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AUSTROBAILEYA

A Journal of Plant Systematics
and
Conservation Biology

Queensland Herbarium

Department of Science, Information Technology, Innovation and the Arts

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A taxonomic revision of *Euphorbia* section *Anisophyllum* Roeper (Euphorbiaceae) in Australia

David A. Halford & Wayne K. Harris

Summary

Halford, D.A. & Harris, W.K. (2012). A taxonomic revision of *Euphorbia* section *Anisophyllum* Roeper (Euphorbiaceae) in Australia. ***Austrobaileya* 8(4): 441–600.** A systematic study of *Euphorbia* section *Anisophyllum* Roeper in Australia is presented. A total of 58 species are recognised of which 51 are native (48 endemic) and seven are naturalised. Twenty one species are described here as new: *E. accedens* Halford & W.K.Harris, *E. albrechtii* Halford & W.K.Harris, *E. crassimarginata* Halford & W.K.Harris, *E. fitzroyensis* Halford & W.K.Harris, *E. gregoriensis* Halford & W.K.Harris, *E. hassallii* Halford & W.K.Harris, *E. laciniloba* Halford & W.K.Harris, *E. litticola* Halford & W.K.Harris, *E. macdonaldii* Halford & W.K.Harris, *E. multifaria* Halford & W.K.Harris, *E. occulta* Halford & W.K.Harris, *E. papillata* Halford & W.K.Harris, *E. papillifolia* Halford & W.K.Harris, *E. philochalix* Halford & W.K.Harris, *E. porcata* Halford & W.K.Harris, *E. psilosperma* Halford & W.K.Harris, *E. thelephora* Halford & W.K.Harris, *E. trigonosperma* Halford & W.K.Harris, *E. verrucitesta* Halford & W.K.Harris, *E. vicina* Halford & W.K.Harris and *E. victoriensis* Halford & W.K.Harris. New species are illustrated while all species are described and their distributional range mapped, and notes on their distribution, habitat and phenology are given. Eleven new varieties are described as new: *E. australis* var. *glabra* Halford & W.K.Harris, *E. australis* var. *hispidula* Halford & W.K.Harris, *E. ferdinandi* var. *appendiculata* Halford & W.K.Harris, *E. ferdinandi* var. *saxosiplaniticola* Halford & W.K.Harris, *E. inappendiculata* var. *robustior* Halford & W.K.Harris, *E. mitchelliana* var. *longiloba* Halford & W.K.Harris, *E. papillata* var. *laevicaulis* Halford & W.K.Harris, *E. papillifolia* var. *polyandra* Halford & W.K.Harris, *E. thelephora* var. *australis* Halford & W.K.Harris, *E. thelephora* var. *rugosa* Halford & W.K.Harris, and *E. vaccaria* var. *erucoides* Halford & W.K.Harris. The new combinations *E. macdonaldii* var. *potentillina* (Baill.) Halford & W.K.Harris, based on *E. australis* var. *potentillina* Baill., *E. mitchelliana* var. *filipes* (Benth.) Halford & W.K.Harris, based on *E. filipes* Benth., and *E. schultzii* var. *comans* (W.Fitzg.) Halford & W.K.Harris based on *E. comans* W.Fitzg., are made. Lectotypes are chosen for *E. alsiniflora* Baill., *E. armstrongiana* Boiss., *E. australis* var. *semiglabra* Domin, *E. comans* W.Fitzg., *E. distans* W.Fitzg., *E. erythrantha* F.Muell., *E. inappendiculata* Domin, *E. filipes* Benth., *E. macgillivrayi* Boiss., *E. macgillivrayi* var. *yarrabensis* Domin, *E. macgillivrayi* var. *pseudoserrulata* Domin, *E. macgillivrayi* f. *glabrata* Domin, *E. mitchelliana* Boiss., *E. mitchelliana* var. *cairnsiana* Domin, *E. mitchelliana* var. *dietrichiae* Domin, *E. mitchelliana* var. *glauca* Benth., *E. mitchelliana* var. *stenophylla* Benth., *E. petala* Ewart & L.R.Kerr, *E. schizolepis* F.Muell. ex Boiss. and *E. schultzii* Benth. Keys to identify the species and varieties are provided.

Key Words: Euphorbiaceae, *Euphorbia* section *Anisophyllum* Roeper, *Chamaesyce*, Australia flora, taxonomy, nomenclature, identification keys, *E. accendens* Halford & W.K.Harris, *E. albrechtii* Halford & W.K.Harris, *E. australis* var. *glabra* Halford & W.K.Harris, *E. australis* var. *hispidula* Halford & W.K.Harris, *E. crassimarginata* Halford & W.K.Harris, *E. ferdinandi* var. *appendiculata* Halford & W.K.Harris, *E. ferdinandi* var. *saxosiplantiticola* Halford & W.K.Harris, *E. fitzroyensis* Halford & W.K.Harris, *E. gregoriensis* Halford & W.K.Harris, *E. hassallii* Halford & W.K.Harris, *E. inappendiculata* var. *robustior* Halford & W.K.Harris, *E. laciniloba* Halford & W.K.Harris, *E. litticola* Halford & W.K.Harris, *E. macdonaldii* Halford & W.K.Harris, *E. mitchelliana* var. *longiloba* Halford & W.K.Harris, *E. multifaria* Halford & W.K.Harris, *E. occulta* Halford & W.K.Harris, *E. papillata* Halford & W.K.Harris, *E. papillata* var. *laevicaulis* Halford & W.K.Harris, *E. papillifolia* Halford & W.K.Harris, *E. papillifolia* var. *polyandra* Halford & W.K.Harris, *E. philochalix* Halford & W.K.Harris, *E. porcata* Halford & W.K.Harris, *E. psilosperma* Halford & W.K.Harris, *E. thelephora* Halford & W.K.Harris, *E. thelephora* var. *australis* Halford & W.K.Harris, *E. thelephora* var. *rugosa* Halford &W.K.Harris, *E. trigonosperma* Halford & W.K.Harris, *E. vaccaria* var. *erucoides* Halford & W.K.Harris, *E. verrucitesta* Halford & W.K.Harris, *E. vicina* Halford & W.K.Harris, *E. victoriensis* Halford & W.K.Harris

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Introduction

In its broadest sense *Euphorbia* L. is one of the largest genera of angiosperms in the world comprising at least 2100 species and has an almost cosmopolitan distribution (Riina & Berry 2012). The morphological element that unifies this diverse genus is the cyathium which consists of a central pistillate flower surrounded by five clusters of staminate flowers within a cup-like involucre with a ring of lobes and glands on the rim. This unique reproductive structure resembles a bisexual flower and is generally interpreted as a complex pseudanthium. Recent studies present evidence that the cyathium could involve the expression of floral as well as inflorescence developmental pathways (Prenner & Rudall 2007; Prenner *et al.* 2011).

Euphorbia s.l. includes an astonishing array of vegetative forms from small leafy annuals to large cactus-like trees (Horn *et al.* 2012). Given the size and morphological diversity of the genus it is not surprising that the taxonomy of this genus is complex and often considered controversial. This is reflected in a long history of attempts to dismember the genus into numerous more homogeneous groups (e.g. *Chamaesyce* Gray, *Monadenium* Pax, *Pedilanthus* Neck. ex Poit., *Poinsettia* Graham and *Synadenium* Boiss.).

The genus *Chamaesyce* is one of the more easily recognizable segregates that is generally considered to be a 'natural' taxon and more or less well defined by a series of morphological, physiological and developmental characters (Dressler 1961; Webster *et al.* 1975; Hassall 1976; Evans & Kinghorn 1977; Koutnik 1987; Hayden 1988; Benedí & Orell 1992; Yang & Berry 2011). It is characterised by having a sympodial growth pattern, predominance of C_4 photosynthesis with the associated Kranz leaf anatomy, leaves opposite (predominantly distichous) and mostly asymmetrical at the base with interpetiolar stipules and seeds ecarunculate. The genus is widely distributed in subtropical and tropical regions throughout the world, with a particular centre of diversity in North America and is estimated to contain *c.* 350 species (Hassall 1977; Yang & Berry 2011). As in other regions of the world the recognition of *Chamaesyce* in Australia has had limited acceptance (James & Harden 1990; Forster & Henderson 1995).

The current trends are tending to favour the adoption of a broad concept of the genus *Euphorbia* as recent phylogenetic analyses involving morphological characters (Park & Elisens 2000) and molecular sequence data (Steinmann & Porter 2002; Bruyns *et al.* 2006; Park & Jansen 2007; Zimmermann *et al.* 2010; Bruyns *et al.* 2011; Horn *et al.* 2012) indicate that the previously recognised segregated genera are nested well within *Euphorbia*. The six molecular phylogenies resolved *Euphorbia s.l.* into four major, well supported clades (A–D) which are formally recognised as subgenera (A = *E.* subg. *Rhizanthium* (Boiss.) Wheeler; B = *E.* subg. *Esula* Pers.; C = *E.* subg. *Euphorbia*; D = *E.* subg. *Chamaesyce* Raf.) (Bruyns *et al.* 2006, 2011; Horn *et al.* 2012). Yang *et al.* (2012) have recircumscribed *E.* subg. *Chamaesyce* and presented a formal classification, recognizing 15 sections. The previous segregated genus *Chamaesyce* is deeply imbedded within *E.* subg. *Chamaesyce* and formally recognised at the sectional level namely *E.* sect. *Anisophyllum* Roeper (Yang *et al.* 2012).

Euphorbia section *Anisophyllum* in Australia

In De Candolle's *Prodromus*, Boissier (1862) enumerated 15 species of *Euphorbia* sect. *Anisophyllum* that are relevant to the Australian flora. In his account of *Euphorbia* in *Flora Australiensis*, Bentham (1873) recognised 17 species within *E.* sect. *Anisophyllum*, one species *E. hirta* L. (as *E. pilulifera* L.) appears to be an early naturalisation. Since Bentham's work numerous species (18) and infraspecific (13) taxa based on Australian material have been described by various botanists (e.g. Fitzgerald 1918; Domin 1927; Thomson 1992). The taxonomy of the Australian species of *E.* sect. *Anisophyllum* has not been reviewed on a national level since 1977. Hassall (1977) as part of his doctoral studies on the tribe *Euphorbieae* in Australia, recognised 22 native species as well as 14 infraspecific taxa. He supported the recognition of *Chamaesyce* (*E.* sect. *Anisophyllum*) as distinct from *Euphorbia* and transferred 15 names to

Chamaesyce (Hassall 1976). He proposed a number of new taxa (species, subspecies and varieties) and lectotypifications but these were never validly published and the majority of his taxonomy on this group has remained unpublished.

The first author found that while preparing an account of *Euphorbia* for the *Flora of Australia* that it was apparent there were considerable taxonomic problems in this section of the genus. Many more collections and information relevant to the taxa concerned have become available since Hassall's work. A number of the species were previously poorly known and there was confusion over the application of some names. We have found, as Bentham and Hassall have before us, that the specific and infraspecific boundaries in the Australian *E.* sect. *Anisophyllum* are not easily defined. Although some morphological features such as seeds are reasonably diagnostic for individual species, variation across most characters is extensive. However, it is felt that separation of these entities at the specific rank is more desirable than having a few 'mega-species' with numerous infraspecific units. While the present study resolves many taxonomic issues in the Australian species of *E.* sect. *Anisophyllum*, still other problems remain to be examined in more detail.

We have recognised 58 species of which 51 are native (48 endemic) and seven are naturalised. Three native species (*Euphorbia bifida* Hook. & Arn., *E. obliqua* Endl. and *E. pallens* Dillwyn) extend to South East Asia and the south west Pacific. The species of *Euphorbia* sect. *Anisophyllum* are widespread in Australia and are present in all States although only a handful of species occur in Victoria (Vic) and Tasmania has none. Most species occur in the northern and central part of the continent where there are six main centres of species' richness: Hamersley – Pilbara (Western Australia [WA]), Kimberley – Victoria River (WA & Northern Territory [NT]), north western Highlands (Queensland [Qld]), Einasleigh – Desert Uplands (Qld), MacDonnell Ranges – Finke (NT & South Australia [SA]) and northern Flinders Range (SA).

Cytology

The cytology findings reported by Hassall (1976, 1977) have been re-interpreted in light of the present study. The voucher collections (lodged at BRI) from that study have been re-determined in line with the taxa recognised here (**Appendix 1**). Hassall recorded two base chromosome numbers for the Australian taxa, $n = 8$ & 11 as well as an apparent tetraploid ($n = 22$) race of *E. dallachyana* Baill.

Groupings of species within *E.* sect. *Anisophyllum* in Australia

Boissier (1862) arranged the then known species in *E.* sect. *Anisophyllum* into eight subsections. The Australian taxa that he dealt with were placed into four subsections: *E.* subsect. *Chamaesyce* Boiss. (*E. armstrongiana* Boiss, *E. australis* Boiss., *E. drummondii* Boiss., *E. erythrantha* F.Muell. [= *Euphorbia australis* var. *erythrantha* (F.Muell.) Benth., in this revision], *E. minutifolia* Boiss.[= *E. dallachyana*, in this revision]); *E.* subsect. *Elegantes* Boiss. (*E. schhizolepis*); *E.* subsect. *Hypericifoliae* Boiss. (*E. baueri*, unplaced in this revision, *E. bifida*, *E. macgillivrayi* (= *E. bifida*, in this revision), *E. micradenia* (= *E. bifida*, in this revision), *E. mitchelliana* Boiss., *E. muellerii* Boiss.); *E.* subsect. *Sclerophyllae* Boiss. (*E. atoto* (= *E. pallens*, in this revision), *E. myrtoides* Boiss., *E. obliqua*). Bentham (1873) did not recognise any subdivisions within *E.* sect. *Anisophyllum* and made no comment regarding Boissier's groupings.

Yang & Berry (2011) found Boissier's classification to be of little value in designating monophyletic groups within *Euphorbia* sect. *Anisophyllum*. Their data supported three main lineages within the group namely the "Acuta", "Peplis" and "Hypericifolia" clades. All the Australian species sampled (*E. australis*, *E coghlanii* F.M.Bailey, *E. dallachyana*, *E. carissoides* F.M.Bailey, *E. schultzii* Benth., *E. schizolepis* F.Muell. ex Boiss., *E.* sp. nov. 'Australia' = *E. occulta* Halford & W.K.Harris) were found to group within the large cosmopolitan distributed Hypericifolia clade (= *E.* subsect. *Hypericifoliae* Boiss., Yang *et al.* (2012).

Hassall (1977) evaluated the relationships within the Australian species of *Chamaesyce* (= *E.* sect. *Anisophyllum*) using numerical techniques involving morphological and cytological data. He noted a good correlation in the data and organised the Australian species into three groups that essentially corresponded to karyotype variation which parallelled, to some degree, patterns in morphology in the Australian species. Our observations generally support Hassall's delimitation of the Australian species into three groups. These groups are:

Group 1 (*E.* sect. *Chamaesyce* [Hassall 1977]): This, represented by 35 species, is the largest and most widespread of the three groups. The species are found mostly in inland habitats. The plants are generally of small stature (mostly <40 cm) and often with prostrate or decumbent stems; leaves are small (2–25 × 1–9 mm); cyathia solitary at the nodes although often clustered on shortened leafy lateral branchlets; seeds small (0.7–2.2 mm long), generally tetraquetrous in cross-section, with surfaces variously finely sculptured or smooth, mostly mucilaginous when moistened. Fourteen of the species have been recorded having chromosome number n =11 and one species with a tetraploid race n = 22 (**Appendix 1**).

Within this group there are a number of subgroupings that we perceive to be morphologically similar species. These are:

subgroup australis: *E. accedens* Halford & W.K.Harris, *E. australis*, *E. careyi* F.Muell., *E. centralis* B.G.Thomson, *E. macdonaldii* Halford & W.K.Harris, *E. occulta*, *E. schutlzii*, *E. thelephora* Halford & W.K.Harris, *E. vaccaria* Baill.

subgroup drummondii: *E. drummondii*, *E. dallachyana*, *E. fitzroyensis* Halford & W.K.Harris, *E. flindersica* Halford & W.K.Harris, *E. gregoriensis* Halford & W.K.Harris, *E. hassallii* Halford & W.K.Harris, *E. philochalix* Halford & W.K.Harris, *E. porcata* Halford & W.K.Harris, *E. verrucitesta* Halford & W.K.Harris.

subgroup ferdinandi: *E. crassimarginata* Halford & W.K.Harris, *E. ferdinandi* F.Muell., *E. papillata* Halford & W.K.Harris, *E. multifaria* Halford & W.K.Harris.

subgroup ophiolitica: *E. laciniloba* Halford & W.K.Harris, *E. maconochieana* B.G.Thomson, *E. ophiolitica* (P.I.Forst.) Y.Yang, *E. papillifolia* Halford & W.K.Harris.

subgroup petala: *E. albrechtii* Halford & W.K.Harris, *E. cinerea* W.Fitzg., *E. petala* Ewart & L.R.Kerr.

subgroup wheerleri: *E. myrtoides*, *E. sharkoensis* Baill., *E. victoriensis* Halford & W.K.Harris, *E. wheeleri* Baill.

Unplaced species: *E. inappendiculata* Domin, *E. armstrongiana*.

Group 2 (*E.* sect. *Sclerophyllae* [Hassall 1977]): This group is represented by 13 species. The species are in coastal and inland habitats in mostly northern Australia. The plants are generally of larger stature (up to 80 cm) and often with decumbent or erect stems; leaves are generally larger (5–80 × 1–22 mm); cyathia solitary at the nodes or in lax to congested, leafy to bracteose dichasia; seeds generally larger (1–2.2 mm long), tetragonous, trigonous, biconvex or suborbicular in cross-section, with surfaces variously finely sculptured or smooth, non-mucilaginous or mucilaginous when moistened. Five of the species have been recorded having chromosome number n =8 (**Appendix 1**).

The following groupings are perceived to be morphologically similar species.

subgroup coghlanii: *E. biconvexa* Domin, *E. clementii* Domin, *E. coghlanii*, *E. psilosperma* Halford & W.K.Harris, *E. trigonosperma* Halford & W.K.Harris.

subgroup pallens: *E. litticola* Halford & W.K.Harris, *E. muelleri*, *E. obliqua*, *E. pallens*, *E. psammogeton* P.S.Green.

subgroup bifida: *E. bifida*, *E. mitchelliana*, *E. vicina* Halford & W.K.Harris.

Group 3 (*E.* sect. 'Elegantes' [Hassall 1977]): This group is represented by 3 species. The species occur in inland habitats of northern Australia. The plants are generally of larger stature (up to 120 cm) and mostly decumbent to erect stems; leaves are ± large (5–36 × 3–19 mm);

cyathia solitary at the nodes; seeds large (1.9–3.2 mm long), tetragonous or tetraquetrous in cross-section, with surfaces variously coarsely sculptured or smooth, and mucilaginous when moistened. The chromosome number for these species is unknown.

Included species: *E. carissoides*, *E. kimberleyensis* B.G.Thomson, *E. schizolepis*.

The groups and subgroups have not been given formal names for it is more appropriate that this be done within the context of a broader investigation. In the following 'Taxonomy' section we have arranged the species alphabetically.

Materials and methods

This study has been primarily herbarium based, together with field work undertaken by the authors. Herbarium collections on loan to BRI from herbaria AD, DNA, HO, MEL, NSW, NT and PERTH were studied and annotated, and selected material from G, K, P and W was also seen. The Herbarium acronyms follow Holmgren *et al.* (1990). All specimens cited in this revision have been examined by one or both of the authors, unless indicated otherwise by '*n.v*'. Those specimens seen only as a digital image either online (http://www.jstor.org) or images sent from other herbaria in lieu of sending the specimen are indicated by 'image seen' while those seen only as a microfiche image are indicated by the citation of the relevant IDC microfiche. Unless otherwise stated the species in this treatment are endemic to Australia. Species considered naturalised in Australia are indicated by an asterisk '*' preceding the species name in the 'key to species' and in the main species entry in the 'Taxonomy' section. The descriptions of the species' naturalised in Australia are based on the variation observed in specimens collected from Australia and therefore may not reflect the full variation observed in the species over its native range.

The revision is based on an assessment of morphological characters of about 5300 dried herbarium collections. We used the alpha taxonomic techniques of studying characters of the specimens and repeatedly sorting the specimens into groups until the most efficient characters for sorting had been determined. Measurements in tenths of a millimetre were made with a dissecting microscope at 10 to 40 times magnification and eyepiece graticule. Descriptions of colour of vegetative and floral parts are either from the information on herbarium labels or information recorded by the authors during field studies. The ventral surface of the seed is the side facing towards the centre of the capsule before dehiscence; the dorsal surface is the side facing away from the centre of the capsule. Seed shape is the outline of the seed when the dorsal surface is viewed radially. All measurements were made either on fresh material, dried material, material preserved in 70% ethanol or dried material reconstituted by placing in boiling water for a few minutes. Measurements listed are based upon the total variation observed in the herbarium specimens examined. Information on plant size, flowering and fruiting times, and habitat of occurrence was obtained from herbarium labels. Locality data on herbarium specimens were used to generate the distribution maps using DIVA-GIS version 7.5.0.0.

Seed photographs were taken with a Nikon DS-Fi1 microscope camera attached to a stereomicroscope (Leica MZ6). Single images were combined with Helicon Focus version 5.2 (Helicon Soft, http://HeliconFocus.com) to produce composite images to increase the depth of field. A small number of mature seeds of each taxa where tested for the production of a mucilaginous layer by using the method of Jordan & Hayden (1992). Seeds were hydrated in water for 5 min, then examined under a dissecting microscope for the presence of mucilage.

Although the taxa studied flower and fruit early in their development there are many herbarium collections that we have been unable to identify to species because the collections were of insufficient quality or lacking sufficient floral or fruiting parts (e.g. seeds).

Common abbreviations used in the specimen citations include N.P. (National Park), N.R. (Nature Reserve) and S.F. (State Forest).

Taxonomy

Euphorbia sect. **Anisophyllum** Roeper in J.E.Duby, *Bot. Gall.* 2nd edn, 1: 412 (1828). **Type:** *Euphorbia peplis* L. (lecto: *fide* Wheeler [1941: 111]).

Chamaesyce Gray, *Nat. Arr. Brit. Pl.* 2: 260 (1821). **Type:** *Chamaesyce maritima* Gray, *nom. illeg.*, = *C. peplis* (L.) Prokh. (lecto: *fide* Millspaugh [1909: 300] *n.v.*, fromYang *et al.* [2012]).

Monoecious (rarely dioecious) annuals or herbaceous perennials, few to many stems arising from crown of taproot, milky latex in all parts, growth sympodial, the primary axis exhibits no further development above the epicotyl, growth continues through development of lateral or secondary axes. Stipules present, persistent, connate forming interpetiolar sheath, entire or deeply bipartite. Leaves opposite, distichous, petiolate, usually with Kranz anatomy, the blades entire to variously toothed, base is usually markedly asymmetrical. Cyathia terminal but appearing axillary, solitary at the nodes, or in lax to congested, leafy to bracteose dichasia. Involucre with 4 (rarely 5 or 6) glands; glands with or without petaloid appendages. Staminate flowers few to many, pedicellate, naked and monandrous. Pistillate flowers pedicellate, naked, hypogynous disc entire or fimbriate; ovary 3-locular with one pendant ovule in each locule; styles 3, free or basally connate, bifid or entire. Fruit capsular, 3-seeded, separating septicidally into three 2-valved cocci leaving a persistent columella. Seeds ecarunculate, smooth or variously sculptured, mucilaginous or non-mucilaginous when moistened.

Key to species of *Euphorbia* section *Anisophyllum* in Australia (distribution in states indicated by acronyms)

1 Capsules with hairs **2**
1. Capsules glabrous **28**

2 Indumentum on stems consisting of two hairs types; white short ± appressed crispate hairs to 0.5 mm long and yellow spreading segmented hairs to 1.5 mm long; cyathia in dense capitate, terminal or axillary cymose clusters **3**
2. Indumentum on stems consisting of one hair type or absent; cyathia solitary, clustered on congested lateral branchlets, or in lax to congested leafy terminal and axillary dichasial cymes **4**

3 Stems prostrate or rarely decumbent; cyathia in terminal cymose clusters (NSW, Qld) . . . . **37. *E. ophthalmica**
3. Stems ascending to erect; cyathia in terminal and axillary cymose clusters (NSW, NT, Qld, WA) . . . . **21. *E. hirta**

4 Capsules with hairs unevenly distributed over surface either restricted to keels or towards the base of the capsule **5**
4. Capsules with hairs evenly distributed over surface **10**

5 Seeds >1.9 mm long (WA) . . . . **24. E. kimberleyensis**
5. Seeds <1.9 mm long **6**

6 Capsules with hairs mostly towards the base; hairs ≥0.8 mm long (NT, WA) . . . . **54. E. vaccaria**
6. Capsules with hairs restricted to keels; hairs mostly <0.8 mm long **7**

7 Capsules ≤1.5 mm across; involucral gland appendages <0.2 mm long; staminate flowers per cyathium <10; stems prostrate or weakly ascending, glabrous on lower surface (NSW, NT, Qld, WA). . . . . **44. *E. prostrata**
7. Capsules >1.5 mm across or if less then involucral gland appendages >0.2 mm long, staminate flowers per cyathium >10 and stems erect or if prostrate or ascending then evenly hairy **8**

8 Capsules distinctly wider than long, 2–3 mm across, deeply 3-lobulate (NT, Qld, WA) . . . . **48. E. schultzii**
8. Capsules ± as long as wide, 1.5–2.3 mm across, shallowly 3-lobulate. **9**

9 Leaf blades 7–70 mm long, glabrous or with a few scattered hairs, with margins entire or finely serrulate; seeds tetragonous or trigonous in transverse section; seed surfaces with 3–7 prominent narrow rounded transverse ridges (NT, Qld,WA) . . . . **30. E. mitchelliana**
9. Leaf blades 3–7 mm long, sparsely to densely hairy, with margins often coarsely serrate; seeds tetraquetrous in transverse section; seed surfaces with low faint to distinct irregular ridges (NT, Qld, SA, WA) . . . . **9. E. centralis**

10 Seeds ≥1.9 mm long **11**
10. Seeds <1.9 mm long. **12**

11 Stems decumbent to erect, moderately to densely hairy with hairs to 2 mm; involucral gland appendages dentate to deeply laciniate, hairy abaxially or if glabrous then styles entire (NT, WA). . . . . **47. E. schizolepis**
11. Stems usually prostrate, sparsely to densely hairy with hairs to 0.3 mm long; involucral gland appendages entire or shallowly lobed, glabrous; styles bifid (NT) . . . . **31. E. muelleri**

12 Gland appendages erect concealing involucral glands; involucral lobes obovate, 0.8–1 mm long (Qld) . . . . **35. E. occulta**
12. Gland appendages spreading radially not concealing involucral gland or absent; involucral lobes triangular to broad-triangular or subulate, 0.2–0.8 mm long **13**

13 Styles entire or scarcely notched **14**
13. Styles bifid for at least 1/3 of their length **18**

14 Seeds <1 mm long (NT, Qld) . . . . **27. E. macdonaldii**
14. Seeds ≥1 mm long **15**

15 Involucral glands patelliform, either ± planar or shallowly concave; gland appendages deeply laciniate with narrow attenuate teeth, ≥0.4 mm long (NT, Qld, SA, WA) . . . . **9. E. centralis**
15. Involucral glands cupuliform, deeply sunken in centre with distinct thickened rim; gland appendages entire or shallowly irregularly lobed or bluntly toothed, up to 0.6 mm long **16**

16 Capsules distinctly longer than wide (NSW, NT, Qld, SA) . . . . **51. E. thelephora**
16. Capsules ± as long as wide or distinctly wider than long **17**

17 Capsules distinctly wider than long; leaf margins serrate; dorsal faces of seeds with 3–5 prominent ± transverse or irregular, broad ridges (NT, Qld, WA) . . . . **48. E. schultzii**
17. Capsules ± as long as wide; leaf margins entire or minutely toothed distally; dorsal faces of seeds with 5–7 prominent ± transverse, narrow ridges (NT, Qld). . . . . **1. E. accedens**

18 Pedicel of mature capsules <1 mm long; capsules not completely exserted from involucre at maturity causing the involucre to split (NT, Qld, WA) . . . . **52. *E. thymifolia**

18. Pedicel of mature capsules ≥1 mm long; capsules completely exserted from involucre at maturity **19**

19 Cyathia in lax terminal dichasia or monochasia or in congested axillary bracteose dichasia **20**

19. Cyathia solitary at nodes or in congested short lateral leafy branches (leaves on lateral branches usually smaller in size than main branches but not reduced to bracts) 22

20 Capsules minutely papillose; gland appendages absent or if present then ≤0.1 mm long (WA) . . . . **56. E. vicina**

20. Capsules smooth; gland appendages present, >0.1 mm long. **21**

21 Cyathia in axillary or terminal congested dichasial cymes (NSW, NT, Qld, WA) . . . . **6. E. bifida**

21. Cyathia in terminal lax dichasial or monochasial cymes (NT, Qld WA) . . . . **30. E. mitchelliana**

22 Hairs on capsules appressed; seeds ≤1 mm long; annual herbs to 10 cm high with prostrate or weakly ascending stems; leaf blades green often with elongate purple spot centrally; stipules 1–2.3 mm long; hairs on stem up to 0.8 mm long (all mainland States) . . . . **29. *E. maculata**

22. Hairs on capsules spreading or if appressed then either seeds >1 mm long or herbaceous perennials with ascending to erect stems or leaf blades yellowish green or stipules <1 mm long or hairs on stems to 0.2 mm long **23**

23 Capsules depressed ovate or transversely elliptic in lateral view, distinctly wider than long, acutely keeled; leaf blades ovate, oblong or obovate, >1.5 times longer than wide (NT, Qld, WA) . . . . **48. E. schultzii**

23. Capsules broad-ovate to very broad-ovate or broad-elliptic in lateral view, as long as wide or if depressed ovate then only slightly wider than long, obtusely keeled and leaf blades elliptic to broad elliptic and ≤1.5 times longer than wide **24**

24 Gland appendages deeply laciniate with narrow attenuate teeth (NT, Qld, SA, WA) . . . . **9. E. centralis**

24. Gland appendages entire, bluntly lobed or acutely toothed **25**

25 Gland appendages white rarely pale pink, entire; stems prostrate; capsules conspicuously papillose and only sparsely hairy with hairs up to 0.1 mm long; leaf blades strongly asymmetric at base (NT, WA) . . . **28. E. maconochieana**

25. Gland appendages red, yellow or if white or pink then irregularly lobed or toothed; stems prostrate, ascending to erect; capsules smooth or if papillose then only minutely so and sparsely to densely hairy with hairs 0.1–0.5 mm long; leaf blades weakly to strongly asymmetric at base **26**

26 Stems longitudinal ribbed (Qld) . . . . **36. E. ophiolitica**

26. Stems not longitudinal ribbed **27**

27 Cyathia mostly unisexual; hairs on stems ≤0.2 mm long; involucral glands ± flat, 0.3–0.5 mm long by 0.4–0.8 mm wide (WA) . . . . **7. E. careyi**

27. Cyathia bisexual; hairs on stems >0.2 mm long or if equal to or shorter then involucral glands concave or with shallow central pit, <0.3 mm long and <0.4 mm wide (all mainland States except Vic) . . . **4. E. australis**

28 Dorsal faces of seeds smooth, without ornamentation or surface irregularities; seeds tetragonous, trigonal, biconvex or suborbicular in transverse section **29**

28. Dorsal faces of seeds sculptured or variously ornamented sometimes only obscurely so or if smooth then seed tetraquetrous in transverse section. **37**

29 Involucral glands, sessile, pressed flat against the outer surface of the involucre; gland appendages absent; involucral lobes oblong to obovate, deeply laciniate distally, ≥1 mm long (WA) . . . . **11. E. clementii**

29. Involucral glands stipitate, spreading; gland appendages usually present sometimes inconspicuous; involucral lobes triangular to subulate, mostly <1 mm long **30**

30 Capsules ≥3.5 long; seeds ≥1.9 mm long; styles ≥1.5 mm long; herbaceous woody perennials to 120 cm high (Qld) . . . . **8. E. carissoides**

30. Capsules <3.5 mm long; seeds <1.9 mm long; styles mostly <1.5 mm long; herbaceous perennials mostly less than 80 cm high **31**

31 Seeds biconvex in transverse section (NT, Qld, SA, WA) . . . . **5. E. biconvexa**

31. Seeds trigonous or suborbicular or tetragonous in transverse section **32**

32 Capsules ≥3 mm long; stipules ≥2 mm long (NT, Qld, WA). . . . . **26. E. litticola**

32. Capsules <3 mm long; stipules <2 mm long **33**

33 Leaf blades <5 mm wide; styles entire or scarcely divided distally (NT, WA) . . . . **46. E. psilosperma**

33. Leaf blades >5 mm wide or if less then styles bifid for one third or more of their length **34**

34 Stipules triangular to broad-triangular, pubescent on adaxial surface; seeds not becoming mucilaginous when moistened; growing on sandy coastal foreshores **35**

34. Stipules subulate to narrow-triangular, glabrous on adaxial surface; seeds mucilaginous when moistened; growing in inland areas on various soils and coastal sands **36**

35 Leaf blades ≤20 mm long and ≤10 mm wide; cyathia solitary in upper axils (Qld) . . . . **34. E. obliqua**

35. Leaf blades >20 mm long and >10 mm wide; cyathia in congested dichasial cymes (Qld) . . . . **38. E. pallens**

36 Seeds suborbicular in transverse section; plants most commonly growing on clay soils (NT, Qld, WA) . . . . **12. E. coghlanii**

36. Seeds trigonous in transverse section; plants most commonly growing on sandy soils (NT, Qld, WA). . . . . **53. E. trigonosperma**

37 Dorsal and ventral surfaces of seeds with 4–6 transverse grooves or foveate to reticulate-foveate **38**

37. Dorsal and ventral surfaces of seeds smooth, or faintly or distinctly transversely or irregularly ridged **39**

38 Dorsal and ventral surfaces of seeds with 4–6 transverse grooves (**Fig. 25B**) (NT, WA) . . . . **3. E. armstrongiana**
38. Dorsal and ventral surfaces of seeds foveate to reticulate-foveate (**Figs 28L & M**) (all mainland States except Vic) . . . . **58. E. wheeleri**

39 Seeds ≥1.9 mm long, ≥1.5 mm wide **40**
39. Seeds <1.9 mm long or if ≥1.9 mm then <1.5 mm wide **41**

40 Capsules papillose; surface of seeds with low rounded irregular ridges with exotesta distinctly thicker on the ridges; gland appendages dentate to laciniate, (0.5) 1.3–2.5 mm long (WA) . . . . **24. E. kimberleyensis**
40. Capsules smooth; surface of seeds with faint narrow irregular ridges with exotesta of even thickness over surface; gland appendages entire or shallowly lobed, 0.6–1.5 mm long (NT) . . . . **31. E. muelleri**

41 Cyathia in lax to congested leafy terminal dichasia or monochasia or in congested axillary bracteose dichasia **42**
41. Cyathia solitary at the nodes, sometimes clustered on short leafy lateral branches **46**

42 Seeds orbicular or very broad-ovate in outline, ≥1.5 mm long, >1.2 mm wide, ± suborbicular or slightly trigonal in transverse section, surfaces faintly irregularly ridged; capsules >2.5 mm long and >3 mm wide (NSW, Qld) . . . . **45. E. psammogeton**
42. Seeds ovate to elliptic or broad-ovate in outline, <1.5 mm long or if 1.5 mm long then <1.2 mm wide, tetragonous in transverse section or if trigonal in transverse section then surface distinctly ridged; capsules <2.5 mm long and <3 mm wide **43**

43 Capsules minutely papillose; gland appendages absent or if present ≤0.1 mm long (WA) . . . . **56. E. vicina**
43. Capsules smooth; gland appendages present, >0.1 mm long **44**

44 Stipules broad-triangular, 0.3–0.6 mm long, with margins lacerate, teeth gland-tipped (NSW, NT, Qld, WA) . . . . **22. *E. hyssopifolia**
44. Stipules deeply bipartite, lobes subulate to narrow-triangular, 0.6–2 mm long, with margins entire or laciniate, sometimes with teeth gland-tipped **45**

45 Cyathia in terminal lax dichasial or monochasial cymes, usually above subtending leaves (NT, Qld, WA) . . . . **30. E. mitchelliana**
45. Cyathia in congested dichasial cymes, mostly axillary on short lateral branchlets, usually shorter than subtending leaf (NSW, NT, Qld, WA) . . . . **6. E. bifida**

46 Stems hairy, sometimes only proximally **47**
46. Stems glabrous **55**

47 Styles hairy, bifid; capsules smooth, slightly wider than long (Qld) . . . **40. E. papillifolia**
47. Styles glabrous or if with a few scattered hairs then style entire, and capsules papillose and distinctly longer than wide **48**

48 Styles entire, 0.3–1.1 mm long; capsules widest at the middle (NSW, NT, Qld, SA) . . . . **51. E. thelephora**
48. Styles bifid or if entire then 0.2–0.3 mm long and capsules usually wider below the middle **49**

49 Involucral glands cupuliform, deeply sunken in centre with distinct rim **50**
49. Involucral glands patelliform, either ± planar or convave with tangential trough but not deeply sunken in centre with distinct rim **52**

50 Capsules distinctly wider than long, 1.5–1.8 × 2–2.7 mm, deeply 3-lobulate (NT, Qld, WA) . . . . **48. E. schultzii**
50. Capsules only slightly wider than long, 1.4–2.1 × 1.5–2 mm, shallowly 3-lobulate **51**

51 Exotesta ± of even thickness; gland appendages <0.1 mm long or if longer then usually deeply lobed; leaves usually ≥3 times as long as wide (NT, Qld, WA) . . . . **20. E. hassallii**
51. Exotesta of uneven thickness, always thicker on ridges; gland appendages >0.1 mm long, entire; leaves <3 times as long as wide (NT) . . . . **19. E. gregoriensis**

52 Gland appendages conspicuous, ≥0.3 mm long; staminate flowers per cyathia mostly 10 or more; stems sparsely to densely hairy with appressed to spreading hairs ≤0.5 mm long **53**
52. Gland appendages inconspicuous and <0.3 mm long or absent; staminate flowers per cyathia <10; stems sparsely hairy with spreading hairs ≥0.5 mm long **54**

53 Gland appendages reniform, entire; capsules papillose (visible at 10× mag.); styles 0.7–1 mm long (NT, WA) . . . . **28. E. maconochieana**
53. Gland appendages obdeltoid to oblong with toothed margin; capsules smooth; styles 0.4–0.6 mm long (Qld) . . . . **25. E. laciniloba**

54 Styles bifid; involucral glands 0.05–0.15 × 0.1–0.2 mm; gland appendages <0.1 mm long (NSW, NT, Qld, SA, WA) . . . . **23. E. inappendiculata**
54. Styles entire; involucral glands 0.2–0.3 × 0.4–0.5 mm; gland appendages ≥0.1 mm long (NT, Qld) . . . . **7. E. macdonaldii**

55 Seeds faces ± smooth **56**
55. Seeds faces sculptured or variously ornamented sometimes only obscurely so **65**

56 Capsules widest below the middle; seeds <1 mm long **57**
56. Capsules widest at the middle or if widest below middle then seeds >1 mm long. . . . **58**

57 Involucral glands cupuliform; leaf blades oblong or obovate, >1.5 times as long as wide, margins minutely toothed distally (NT, WA) . . . . **10. E. cinerea**
57. Involucral glands patelliform; leaf blades oblong, elliptic to broad elliptic, ≤1.5 times as long as wide, margins serrulate (NT, Qld) . . . **27. E. macdonaldii**

58 Involucral glands cupuliform, surface deeply sunken, often with thickened rim **59**
58. Involucral glands patelliform, surface flat or concave **63**

59 Capsules distinctly longer than wide **60**
59. Capsules more or less as long as wide **61**

60 Gland appendages ≥0.1 mm long; seeds ≥0.7 mm wide (radially) (NSW, NT, Qld, SA) . . . . **40. E. papillata**
60. Gland appendages absent or if present then <0.1 mm long or if 0.1 mm long then seeds <0.7 mm wide (radially) (NSW, NT, Qld, SA, WA) . . . . **16. E. ferdinandi**

61 Stems and capsules conspicuously papillose (visible at 10× mag.) (NSW, NT, Qld, SA) . . . . **40. E. papillata**

61. Stems smooth; capsules smooth or inconspicuously papillose (visible at 40× mag.) **62**

62 Leaf blades ≤2 times as long as wide, oblong, oblong-obovate to obovate, 2.8–7 × 1.6–3.8 mm; stems prostrate, rarely ascending to erect; stipules 0.4–1 mm long (NSW, Qld, SA, Vic, WA) . . . . **32. E. multifaria**

62. Leaf blades >2 times longer than wide, narrow oblong, 6–11 × 2–3.6 mm; stems ascending to erect, rarely prostrate; stipules 0.8–1.5 mm long (NT, Qld) . . . . **39. E. papillata**

63 Styles entire (NSW, NT, Qld, SA) . . . . **51. E. thelephora**

63. Styles bifid 1/3–1/2 of their length **64**

64 Plants monoecious; gland appendages deeply dentate or divided to base, 0.3–0.4 mm long; capsules minutely papillose (visible at 40× mag.); growing in sandy clay soils among rocky outcrops and on gravelly hill slopes (SA) . . . . **18. E. flindersica**

64. Plants dioecious rarely monoecious; gland appendages entire, erose or shallowly irregularly lobed, mostly 0.4–0.9 mm long rarely shorter; capsules smooth or rarely minutely papillose; growing in red clay loams to heavy black clays, rarely sandy soils on plains or undulating to hilly terrain (NSW, Qld) . . . . **40. E. papillifolia**

65 Capsules ≥1.2 times wide as long, transversely broad-elliptic in lateral view, deeply 3-lobulate; involucral glands cupuliform; gland appendages entire (NT, Qld, WA) . . . . **48. E. schultzii**

65. Capsules <1.2 times wide as long, or if ≥1.2 times as long as wide then either capsules broad-ovate to depressed ovate in lateral view and shallowly 3-lobulate or involucral glands patelliform or gland appendages toothed or deeply irregularly lobed **66**

66 Seeds <1 mm long. **67**

66. Seeds ≥1 mm long **71**

67 Styles entire **68**

67. Styles bifid for 1/3–1/2 of their length **69**

68 Involucral glands cupuliform; leaf blades >1.5 times as long as wide, margins minutely toothed distally (NT, WA). . . . . **10. E. cinerea**

68. Involucral glands patelliform; leaf blades ≤1.5 times as long as wide, margins serrulate (NT, Qld) . . . . **27. E. macdonaldii**

69 Stems rooting at nodes; stipules 0.5–0.6 mm long, broadly triangular, not bilobed (NSW, Qld, SA) . . . . **49. *E. serpens**

69. Stems not rooting at nodes; stipules 0.9–1.2 mm long, bilobed, lobes triangular **70**

70 Dorsal faces of seed concave, with prominent irregular rounded ridges; gland appendages entire, crenulate or shallowly irregularly lobed (NT, WA). . . . . **42. E. philochalix**

70. Dorsal faces of seed planar, with faint rounded, irregularly ridges; gland appendages toothed or deeply lobed (WA) . . . . **50. E. sharkoensis**

71 Involucral glands patelliform, flat or concave with tangential trough, rim of gland not thickened **72**

71. Involucral glands cupuliform, deeply sunken in the centre, usually with thickened rim **88**

72 Styles entire or scarcely bifid; capsules broader towards the base; gland appendages ≥0.3 mm long (NT, Qld). . . . . **41. E. petala**
72. Styles bifid for 1/3–1/2 of their length or if entire then capsules broader towards the middle or gland appendages absent or <0.3 mm long **73**

73 Stipules on at least one side of stem triangular to broadly triangular, with toothed margins but not deeply bipartite **74**
73. Stipules deeply bipartite, with lobes subulate to triangular **76**

74 Gland appendages <0.4 mm long and <0.8 mm wide; staminate flowers per cyathium ≤10; hypogynous disc often laciniate (all mainland States) . . . . **14. E. dallachyana**
74. Gland appendages ≥0.4 mm long and ≥0.8 mm wide; staminate flowers per cyathium mostly >10; hypogynous disc entire **75**

75 Leaf blades oblong to oblong-elliptic, >1.5 times as long as wide; seeds <1.5 mm long (Qld). . . . . **25. E. laciniloba**
75. Leaf blades elliptic to broad-elliptic, ≤1.5 times as long as wide; seeds >1.5 mm long (Qld) . . . . **36. E. ophiolitica**

76 Gland appendages <0.2 mm long or absent **77**
76. Gland appendages ≥0.2 mm long. **83**

77 Capsules >2 mm long; stems ascending to erect, rarely prostrate; staminate flowers per cyathium 10–30; styles 0.5–0.9 mm long (WA) . . . . **33. E. myrtoides**
77. Capsules ≤2 mm long; stems prostrate rarely erect; staminate flowers per cyathium 5–15; styles 0.2–0.6 mm long **78**

78 Styles entire, 0.2–0.3 mm long (NSW, Qld, SA, Vic, WA). . . . . **32. E. multifaria**
78. Styles bifid for 1/3–1/2 of their length, 0.3–0.6 mm long **79**

79 Leaves minutely papillose (visible at 40× mag.) **80**
79. Leaves ± smooth **81**

80 Involucral glands well developed, 0.1–0.3 mm long and 0.3–0.5 mm wide; gland appendages ≥0.1 mm long (NSW, Qld) . . . . **40. E. papillifolia**
80. Involucral glands poorly formed up to 0.1 mm long and 0.1–0.2 mm wide; gland appendages absent or <0.1 mm long (NSW, NT, Qld, SA, WA) . . . . **23. E. inappendiculata**

81 Stipules ≥1 mm long; involucral glands up to 0.1 mm long (NSW, NT, Qld, SA, WA). . . . . **23. E. inappendiculata**
81. Stipules <1 mm long; involucral glands >0.1 mm long. **82**

82 Dorsal faces of seeds undulate or obscurely ridged; seeds 1–1.5 mm long, growing in sandy soils on rocky limestone foreshores and coastal sand dunes (north-western WA) . . . . **50. E. sharkoensis**
82. Dorsal faces of seeds distinctly ridged; seeds 1.5–1.7 mm long; growing on inland sand dunes in the Great Victoria Desert (NT, SA,WA) . . . . **57. E. victoriensis**

83 Capsules minutely papillose (visible at 40× mag.); stems not longitudinally ridged (SA) . . . . **18. E. flindersica**
83. Capsules smooth, or if minutely papillose then stems longitudinally ridged when young **84**
84 Staminate flowers <10 per cyathia or if 10 then capsules ≤2 mm long; seeds <1.5 mm long **85**
84. Staminate flowers >10 per cyathia or if 10 then capsules >2 mm long; seeds ≥1.5 mm long **86**

85 Leaves ± smooth; growing in sandy soils on rocky limestone foreshores and coastal sand dunes (north-western WA) . . . . **50. E. sharkoensis**
85. Leaves minutely papillose (visible at 40× mag.); growing in clay soils (mostly derived from basalt) in central Queensland (NSW, Qld) . . . . **40. E. papillifolia**

86 Leaf blades elliptic to broad elliptic; 1–1.5 times as long as wide (Qld) . **36. E. ophiolitica**
86. Leaf blades oblong, ovate, obovate or oblong-elliptic, 1.5–2.2 times as long as wide **87**

87 Capsules ≥2.2 mm long; involucral glands 0.3–0.6 mm long; plants to 40 cm tall, monoecious; stems spreading to erect rarely prostrate; leaves bright green to yellow-green (WA) . . . . **33. E. myrtoides**
87. Capsules <2.2 mm long; involucral glands 0.2–0.4 mm long; plants to 10 cm tall, mostly dioecious; stems prostrate to spreading; leaves blue-green (NSW, Qld) . . . . **40. E. papillifolia**

88 Stipules on at least one side of stem broadly triangular, not deeply bipartite; hypogynous disc mostly laciniate; stems prostrate, rarely erect or ascending (all mainland States) . . . . **14. E. dallachyana**
88. Stipules subulate to triangular, deeply bipartite; hypogynous disc mostly entire; stems ascending to erect or prostrate **89**

89 Gland appendages ≥0.1 mm long **90**
89. Gland appendages <0.1 mm long or absent. **100**

90 Capsules broadest towards the base **91**
90. Capsules broadest towards the equator **94**

91 Dorsal faces of seeds with medial irregular longitudinal ridge (NSW, NT, Qld, SA, WA) . . . . **43. E. porcata**
91. Dorsal faces of seeds irregularly ridged but without medial longitudinal ridge **92**

92 Styles entire or scarcely bifid at the tip (NT, Qld) . . . . **41. E. petala**
92. Styles bifid for 1/3–1/2 of their length **93**

93 Dorsal faces of seed with low faint irregular ridges; plants usually robust herbaceous perennials to 30 cm tall; stems erect rarely prostrate; gland appendages 0.2–0.4 mm long (NT, WA) . . . . **2. E. albrechtii**
93. Dorsal faces of seeds with prominent irregular ridges; plants slender herbaceous perennials to 15 cm tall; stems prostrate rarely ascending; gland appendages 0.1–0.3 mm long (NT, WA) . . . . **42. E. philochalix**

94 Leaf blades ≥3 times as long as wide; seeds 0.8–1.3 mm long, distinctly or obscurely irregularly ridged; styles scarcely bifid to divided *c.* 1/3 of their length; involucral glands 0.3–0.5 mm wide (NT, Qld, WA) . . . . . **20. E. hassallii**

94. Leaf blades <3 times as long as wide or if up to 3.3 times as long as wide then either seeds >1.3 mm long and obscurely irregularly ridged, or styles entire, or involucral glands <0.2 mm wide **95**

95 Seeds <1.2 mm long or if ≥1.2 then dorsal faces of seeds with a medial longitudinal ridge **96**

95. Seeds ≥1.2 mm long; dorsal faces of seeds smooth or with irregular ridges **98**

96 Styles entire; capsules minutely papillose; stems longitudinally ridged (NT, Qld) . . . . . **39. E. papillata**

96. Styles divided for 1/3–1/2 of their length; capsules smooth; stems not longitudinally ridged **97**

97 Dorsal faces of seeds irregularly ridged (NSW, NT, Qld, SA, WA) . . . . . **23. E. inappendiculata**

97. Dorsal faces of seeds with a medial longitudinal ridge (NSW, NT, Qld, SA, WA) . . . . . **43. E. porcata**

98 Styles entire, 0.1–0.3 mm long; capsules papillose (NT, Qld) . . . . . **39. E. papillata**

98. Styles divided for 1/3–1/2 of their length, 0.3–0.5 mm long; capsules smooth or papillose **99**

99 Erect annual to 40 cm tall; exotesta of uneven thickness, always thicker on ridges; involucral lobes >0.4 mm long (NT) . . . . . **19. E. gregoriensis**

99. Prostrate to procumbent perennial; exotesta of even thickness; involucral lobes <0.4 mm long (Qld) . . . . . **40. E. papillifolia**

100 Gland appendages absent; involucral glands well developed 0.2–0.3 mm long and 0.4–0.5 mm wide with conspicuous thickened rim; leaf blades >3 times as long as wide and >7 mm long (NT, Qld) . . . . **13. E. crassimarginata**

100. Gland appendages usually present but inconspicuous or if absent then either leaf blades <3 times as long as wide and mostly <7 mm long or involucral glands poorly formed up to 0.1 mm long and 0.1–0.2 mm wide; involucral glands with or without thickened rim **101**

101 Dorsal surface of seeds with 6–9 transverse ridges; exotesta of uneven thickness, always thicker on ridges (WA) . . . . . **17. E. fitzroyensis**

101. Dorsal faces of seeds with irregular ridges, or tuberculate or if transversely ridged then with 3–6 ridges on dorsal faces of seed; exotesta ± of even thickness over seed surface **102**

102 Styles entire or scarcely notched at the apex, 0.2–0.3 mm long; dorsal surface of seeds distinctly transversely or irregularly ridged; capsules broadest towards the middle **103**

102. Styles bifid for 1/3–2/3 of their length or if entire or scarcely notched at the apex then either dorsal faces of seeds obscurely undulate or capsules broadest towards the base; styles 0.2–0.6 mm long **105**

103 Leaves <6 mm long; stems not longitudinally ribbed; dorsal face of seeds irregularly ridged; exotesta of uneven thickness over seed surface (thicker on ridges) (NSW, Qld, SA, Vic, WA) . . . . **32. E. multifaria**
103. Leaves ≥6 mm long or if <6 mm long then stems longitudinally ribbed, dorsal faces of seeds with 3–6 transverse ridges and exotesta of ± even thickness over surface **104**

104 Leaves rounded at apex; dorsal faces of seeds with 3–6 transverse ridges (NSW, NT, Qld, WA) . . . .**15. E. drummondii**
104. Leaves acute to obtuse at apex, or if rounded then dorsal faces of seeds with irregular ridges (NT, Qld, WA) . . . . **20. E. hassallii**

105 Stipules subulate, 1–1.7 mm long; involucral glands poorly formed up to 0.1 mm long and 0.1–0.2 mm wide (NSW, NT, Qld, SA, WA). . . **23. E. inappendiculata**
105. Stipules narrow-triangular to triangular or if subulate then ≤1.1 mm long; involucral glands well formed, 0.1–0.2 mm long by 0.1–0.7 mm wide **106**

106 Largest leaves >8 mm long, mostly >3 times as long as wide (NT, Qld, WA) . . . . **20. E. hassallii**
106. Largest leaves <8 mm long, <3 times as long as wide **107**

107 Dorsal faces of seeds with an irregularly medial longitudinal ridge (NSW, NT, Qld, SA, WA). . . . .**43. E. porcata**
107. Dorsal faces of seeds undulate, faintly irregularly ridged or with irregular wart-like protuberances. **108**

108 Dorsal faces of seeds with irregular wart-like protuberances (NSW, SA, WA). . . . . **55. E. verrucitesta**
108. Dorsal faces of seeds undulate or only faintly irregularly ridged (NSW, Qld, SA, Vic, WA) . . . . **32. E. multifaria**

1. Euphorbia accedens Halford & W.K.Harris, **species nova** fieri potest, ut *E. accedens* permisceatur cum *E. australi* var. *hispidula* Halford & W.K.Harris et *E. thelephora* var. *rugosa* Halford & W.K.Harris. Ab *E. australi* var. *hispidula* seminibus longioribus 1.3–1.4 mm longis (in vicem 0.9–1.2 mm longis), 5–7 porcis ± transversis rotundatus superficierum dorsalium seminis (in vicem undulatis vel porcatis leviter irregulatim), stylis integris vel vix bifidis (in vicem bifidis 1/3–2/3 longitudinis) necnon ab *E. thelephora* var. *rugosa* seminibus brevis 1.3–1.4 mm longis (in vicem 1.5–1.7 mm longis), capsulis in latere visis lato-ellipticus ± longioribus quam latioribus 1.6–2 mm longis 1.9–2.2 mm latis (in vicem in latere visis 1.8–2.2 mm longis 1.4–1.8 mm latis distincte longioribus quam latioribus) differt. *Euphorbia accedens* formis *E. schultzii* Benth. similis sed capsulis in latere visis ± longioribus quam latioribus 1.6–2 mm longis 1.9–2.2 mm latis leviter 3-lobatis (in vicem in latere visis depresse ovatis vel transverse ellipticis distincte brevioribus quam latioribus valde 3-lobatis), seminum superficiebus porcis transversis rotundatis vel porcatis irregulariter (in vicem 3–5 porcis) marginibus folium integris distaliter dentatis minute (in vicem marginibus folium pro parte maxima dentatis grosse) differt. **Typus:** Queensland. Burke District: Undilla Station, NW of Mt Isa, 18 July 2008, *R.Booth & D.T.Kelman CAM36-7* (holo: BRI).

Monoecious, herbaceous perennial to 5 cm high, with few to many stems arising from thickened woody taproot. **Stems** erect or prostrate, sparingly to much branched, smooth, with a moderately dense indumentum; hairs spreading, ± straight, 0.2–0.8 mm long, white. **Interpetiolar stipules** subulate, 0.3–0.5 mm long, deeply bipartite, with indumentum as for stems; margin entire or laciniate. **Leaves**: petiole 1–1.5 mm long, smooth, with indumentum as for stems; blade oblong or oblong-obovate, 5–12 mm long, 3–6 mm wide, 1.5–2.5 times longer than wide; adaxial and abaxial surfaces pale blue-green sometimes suffused with reddish tinge or reddish tinge along margin, papillose, with a moderately dense indumentum consisting of spreading, ± straight hairs 0.2–0.8 mm long; base asymmetric with one side cordate, the other obtuse to cuneate; margin entire or minutely toothed distally; apex obtuse to rounded sometimes with apiculate tip. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles 0.1–0.4 mm long. **Involucres** cupuliform, 0.8–1.1 mm long, 1–1.2 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin fimbriate; glands 4, stipitate, cupuliform, with distinct tangential trough and thickened rim, transverse-oblong in outline, 0.2–0.3 mm long, 0.3–0.5 mm wide, yellow or pink; gland appendages conspicuous, spreading radially, very broad-obovate or transverse-oblong, 0.2–0.5 mm long, 0.3–0.8 mm wide, white to pink, glabrous, margin entire, erose or shallowly lobed; bracteoles 0.8–0.9 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into numerous subulate glabrous or hirsute segments. **Staminate flowers** 4–7 per cyathium; pedicels 0.6–0.8 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.5 mm long, spreading, minutely papillose, sparsely hairy, entire or scarcely bifid, with terete apices. **Capsules** exserted from involucre on pedicel to 1.5 mm long, broad-elliptic in lateral view, 1.6–2 mm long, 1.9–2.2 mm across, shallowly 3-lobate with keels acute, papillose, with a moderately dense indumentum consisting of spreading hairs 0.1–0.2 mm long; hypogynous disc entire. **Seeds** ovate in outline, 1.3–1.4 mm long, 0.7–0.8 mm tangentially, 0.7–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces planar to concave; all faces with 5–7 prominent ± transverse, rounded ridges; exotesta thin, of uneven thickness, distinctly thicker on ridges, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta dark brown. **Fig. 1**.

***Additional selected specimens examined*: Northern Territory.** Cattle Creek Stud, Wave Hill, Apr 1963, *Napier s.n.* (DNA 10288); *c.* 75 km NW of Lake Surprise, Aug 1991, *Latz 12167* (NT); *c.* 66 km N [of] Tennant Creek, upper Attack Creek catchment, May 1996, *Albrecht 7628 & Latz* (NT); near Alroy Downs Station, May 1947, *Blake 17889* (BRI, DNA); 24 km NW of Wauchope Roadhouse, gas pipeline, Jun 2007, *Latz 22770* (NT). **Queensland.** BURKE DISTRICT: Flora Downs Station, *c.* 120 km NW of Mt Isa, May 2001, *Bailey & Kelman s.n.* (BRI [AQ697493]); Lake Julius Road, 24 km to Mt Isa Copper stack at 58deg., Apr 1998, *Fell 5346* (BRI); Fort Constantine Station, N of Cloncurry, Jun 2003, *Booth 3401 & Kelman* (BRI); 90 km SSW of Cloncurry on the Duchess Road, Feb 2001, *Wannan 2071 & Jago* (BRI). GREGORY NORTH DISTRICT: 10 miles [*c.* 16 km] N of Duchess, May 1963, *Gittins 731* (BRI, NSW).

Distribution and habitat: *Euphorbia accedens* occurs from the Tanami Desert, NT to Cloncurry, in north-western Qld (**Map 1**). It grows in eucalypt woodland or *Triodia* grassland communities on loam or clay soils on low limestone rises or hills, or sometimes on alluvial plains.

Phenology: Flowers and fruits have been collected in February, April to June, August and November.

Notes: *Euphorbia accedens* may be confused with *E. australis* var. *hispidula* Halford & W.K.Harris and *E. thelephora* var. *rugosa* Halford & W.K.Harris. It differs from E. *australis* var. *hispidula* in having longer seeds (1.3–1.4 mm long versus 0.9–1.2 mm long for *E. australis* var. *hispidula*), 5–7 prominent ± transverse, rounded ridges on the dorsal seed faces (versus undulate or faintly irregular ridged for *E. australis* var. *hispidula*) and entire or scarcely bifid styles (versus bifid for 1/3–2/3 of their length for *E. australis* var. *hispidula*. It differs from *E. thelephora* var. *rugosa* in having shorter seeds (1.3–1.4 mm long versus 1.5–1.7 mm long for *E. thelephora* var. *rugosa*) and capsules broad-elliptic in lateral view that are more or less as long as wide, 1.6–2 mm long, 1.9–2.2 mm across (versus elliptic in lateral view, 1.8–2.2 mm long, 1.4–1.8 mm across and distinctly longer than wide for *E. thelephora* var. *rugosa*).

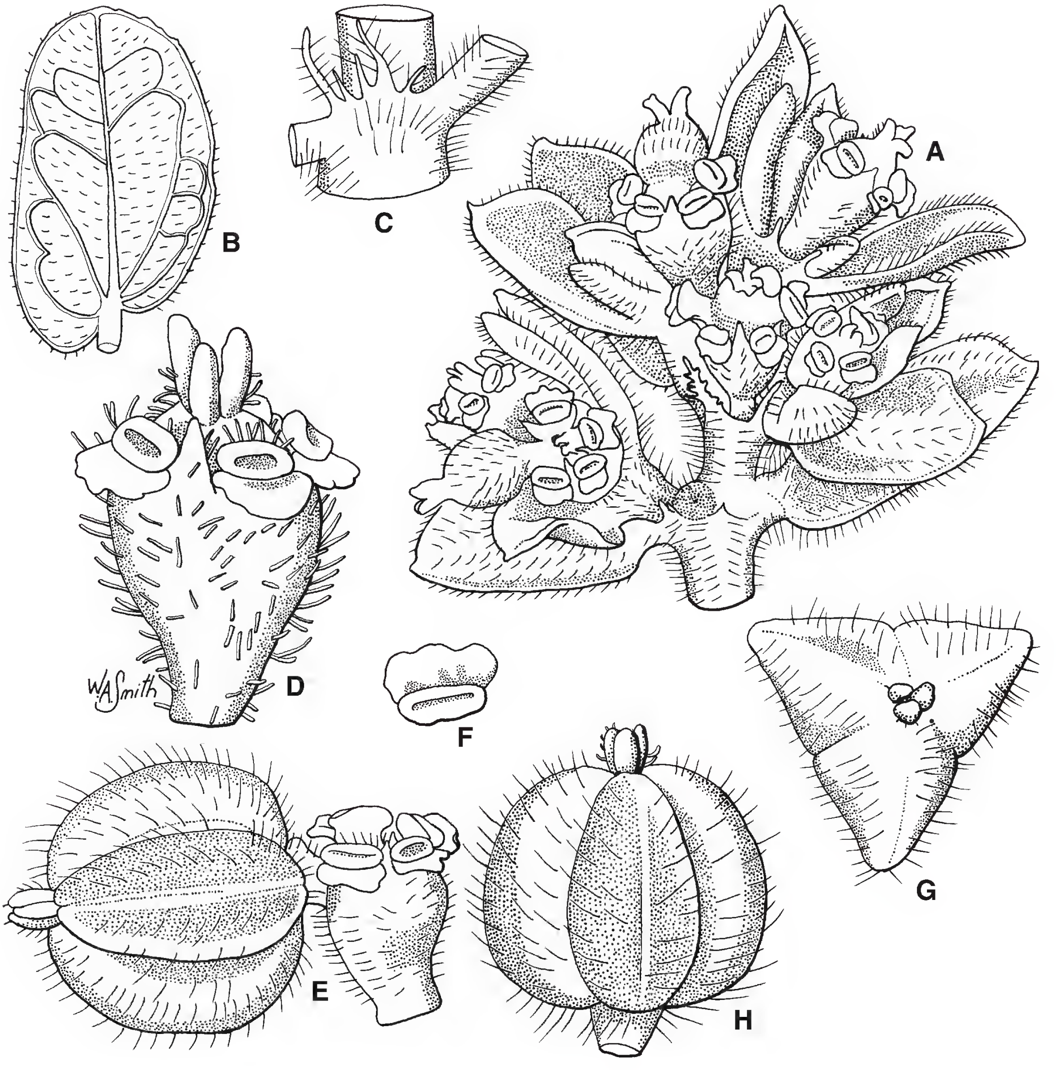

Fig. 1. ***Euphorbia accedens.*** A. branchlet with cyathia ×12. B. leaf ×4. C. stipules ×16. D. cyathia with female flower at anthesis ×32. E. capsule with cyathia ×16. F. cyathial gland, adaxial view ×32. G. capsule, top view ×16. H. capsule, lateral view ×16. A, D from *Gittins 731* (BRI); B, C, E–H from *Booth & Kelman CAM36-7* (BRI). Del. W.Smith.

Euphorbia accedens is similar to some forms of *E. schultzii* but differs in having capsules broad-elliptic in lateral view that are more or less as long as wide, 1.6–2 mm long, 1.9–2.2 mm across and shallowly 3-lobate (versus depressed ovate or transversely elliptic in lateral view and distinctly shorter than wide, 1.5–2.2 mm long, 2–3 mm across, deeply 3-lobate for *E. schultzii*), seed surface with 5–7 prominent ± transverse, rounded ridges or irregularly ridged (versus 3–5 ridges for *E. schultzii*) and leaf margins entire or minutely toothed distally (versus leaf margins mostly coarsely toothed for *E. schultzii*).

***Etymology*:** The specific epithet is from Latin *accedens*, an indeclinable participle meaning approaching, coming near to, or resembling. This alludes to this species' similarity to the taxa *E. australis* var. *hispidula* and *E. thelephora* var. *rugosa*.

2. **Euphorbia albrechtii** Halford & W.K.Harris, **species nova** arcte similis *E. cinereae* W.Fitzg. et *E. petalae* Ewart & L.R.Kerr glandis involucralibus capsulis seminibus sed a duobus habitu robustiore et stylis 1/3–1/2 longitudinis dividis differt. Insuper ab *E. cinerea* glandulae appendicibus longioribus capsulis seminibusque grandioribus et ab *E. petala* glandulae appendicibus brevioribus floribus staminalibus paucioribus in quoque cyathio differt. Nomen *E. drummondii* saepe misapplicatum pro eam. *Euphorbia albrechtii* autem ab illa glandulae appendicibus grandioribus 0.2–0.4 mm longis (in vicem <0.1 mm longis) capsulis latissimis versus basim acute carinatis (ad vicem latissimis ad aequatorem carinatis obtuse) habitu robustiore seminibus porcatis irregulariter (in vicem superficies praeditis porcis distinctis transversis) differt. **Typus:** Northern Territory. 8 km NE [of] Bloods Range Outstation, 1 October 2001, *D.E.Albrecht 10075* (holo: NT).

Monoecious, herbaceous perennial to 30 cm high, many stems arising from crown of thick cylindrical taproot, the whole plant glabrous. **Stems** erect to ascending (rarely prostrate), sparingly to much branched, longitudinally ridged when young. **Interpetiolar stipules** subulate or narrow-triangular, 0.5–1.1 mm long, deeply bipartite to base, glabrous; margin laciniate. **Leaves**: petiole 0.5–0.6 mm long, smooth; blade narrow–oblong, oblong or obovate, 6–9 mm long, 2.3–4 mm wide, 1.8–3 times longer than wide, smooth, green sometimes with reddish tinge on margin; base asymmetric with one side rounded to cordate, the other rounded; margin sparingly minutely toothed distally; apex rounded. **Cyathia** solitary at the nodes, often appearing clustered on short leafy lateral branchlets with subtending leaves usually slightly smaller than primary stem leaves; peduncles *c.* 0.3 mm long. **Involucres** campanulate or turbinate, 0.8–1(–1.4) mm long, 0.7–1.1 mm across; lobes 5, triangular, 0.2–0.4 mm long, margin entire or fimbriate; glands 4, shortly stipitate, cupuliform, with distinct central pit, transverse-oblong in outline, 0.1–0.4 mm long, 0.4–0.7 mm wide, cream or red; gland appendages conspicuous, spreading radially, reniform or depressed obovate, 0.2–0.4 mm long, 0.6–1 mm wide, pink to red or cream, glabrous, entire or shallowly lobed; bracteoles 0.4–0.6 mm long, adnate for *c.* 1/4 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** 2–5 per cyathium; pedicels 0.8–1.1 mm long; staminal filaments 0.1–0.3 mm long. **Pistillate flowers**: styles 0.3–0.5 mm long, spreading with recurved apices, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2 mm long, broad to very broad-ovate in lateral view, 1.5–1.8 mm long, 1.7–2.2 mm across, shallowly 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1–1.3 mm long, 0.5–0.8 mm tangentially, 0.5–0.7 mm radially, tetraquetrous in cross section; dorsal faces planar to concave; ventral faces concave; all faces with low faint irregular smooth ridges; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta red-brown **Figs 2, 25A**.

Additional selected specimens examined: **Western Australia.** Kimberley, May 1984, *Fatchen 965* (AD); just NW of Wolf Creek Crater, Apr 1979, *George 15290A* (BRI, PERTH); Great Sandy Desert, Tanami Track, *c.* 2 km W of NT – WA border, *c.* 225 km SE of Halls Creek, May 1976, *Beauglehole ACB51018* (PERTH); 82 km ESE of Telegraph Line on Ankatell Ridge Road, Aug 1977, *George 14822* (BRI, PERTH); Great Sandy Desert, May 1979, *George 15712* (BRI, PERTH); edge of Great Sandy Desert, *c.* 9 km by road ESE of edge of Gregory Range, at 106 km post WNW from Telfer Mine, Aug 1977, *Jackson 2984* (AD, HO, MEL); Lake Henern, May 1981, *Cane 46* (DNA); 9 miles [*c.* 14 km] W of Mt Webb, Jul 1967, *George 9037* (PERTH); Patience Well, Gibson Desert, Feb 2001, *Campbell 395* (PERTH); 10 miles [*c.* 16 km] N of Giles, Aug 1962, *Kuchel 107* (AD); Serpents Glen, Carnarvon Range, Little Sandy Desert, Aug 2001, *Kenneally K12165 & Edinger E2629* (PERTH); Everard Junction, Gibson Desert N.R., May 1988, *Pearson 395* (PERTH); 81 miles [*c.* 130 km] SW of Warburton Mission, Aug 1961, *George 2900* (PERTH). **Northern Territory**. Gibson Creek, *c.* 56 km N of Tennant Creek, July 1968, *Orchard 861* (AD, DNA); 28 miles [*c.* 45 km] W [of] Frewena R/H, Nov 1971, *Latz 1846* (DNA, NT); Lake Surprise, Mala Paddock near camp, Sep 1993, *Parsons 626* (DNA); Stuart Highway, between Tennant Creek and Barrow Creek, *c.* 11 km N of Wauchope, Jul 1964, *Eichler 17921* (AD); 6 km S [of] Camel Bore, Newhaven Reserve, May 2002, *Latz 18657* (NT); *c.* 6 km SW [of] Midway Bore, *c.* 38 km SE [of] Yuendumu,

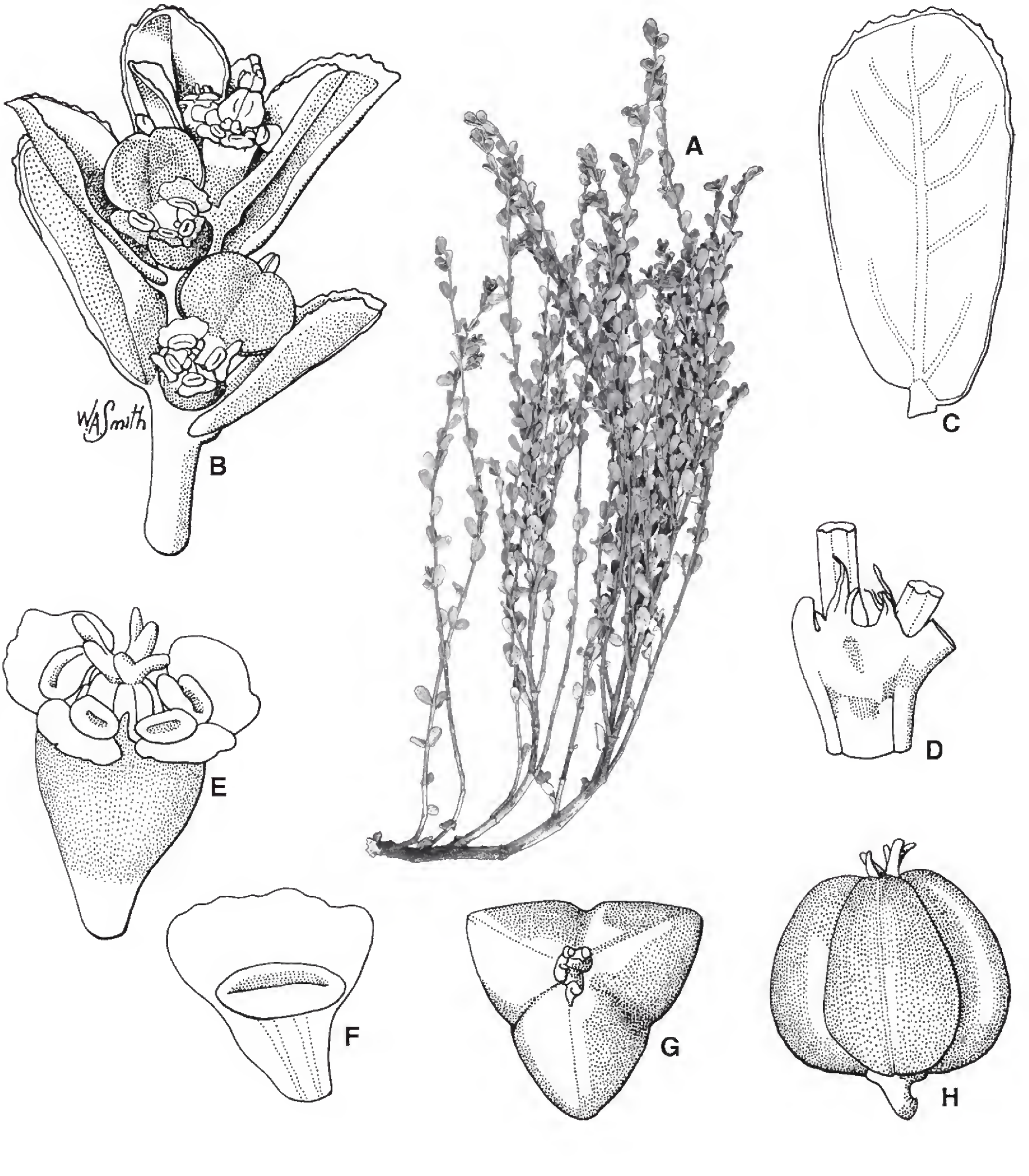

Fig. 2. ***Euphorbia albrechtii***. A. habit ×0.5. B. branchlet with cyathia ×8. C. leaf ×8. D. stipules ×16. E. cyathia with female flower ×24. F. cyathial gland with appendage, adaxial view ×32. G. capsule, top view ×16. H. capsule, lateral view ×16. A–C, E, F from *Albrecht 10075* (NT); D from *Albrecht 6304* (DNA); G, H from *Fatchen 965* (AD). Del. W.Smith.

Mar 1995, *Albrecht 6304* (DNA, MEL); 62 miles [*c.* 100 km] NNW of Alice Springs, Jun 1958, *Winkworth 1458* (DNA, NT); Hamilton Downs, No. 2 desert bore, Apr 1956, *Chippendale 2019* (DNA, MEL).

***Distribution and habitat*:** *Euphorbia albrechtii* extends from the Little and Great Sandy Deserts, WA, eastward through the southern NT to the Qld border (**Map 2**). It grows in *Triodia* grassland communities on red sandy soils on sand plains, inland sand dunes or dune swales. It has often been noted on specimen labels to be growing in areas “recently burnt”.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from May to August.

***Notes*:** *Euphorbia albrechtii* is most similar to *E. cinerea* and *E. petala* which have similar involucral glands, capsules and seeds. It differs from both species by having a more robust habit and styles divided for 1/3–1/2 of their length. It also differs from *E. cinerea* in having longer gland appendages and larger capsules and seeds. It differs from *E. petala* in having shorter gland appendages and fewer staminate flowers per cyathia. These differences are summarized in **Table 1**.

Table 1. Morphological comparison between *Euphorbia albrechtii*, *E. cinerea* and *E. petala*

Character	*E. albrechtii*	*E. cinerea*	*E. petala*
habit	robust erect herbaceous perennial rarely prostrate	slender prostrate herbaceous perennial	slender prostrate herbaceous perennial
involucre length (mm)	0.8–1	0.8–1	1.1–1.5
gland appendage length (mm)	0.2–0.4	0.1–0.3	0.3–1.3
staminate flowers per cyathium	2–5	1–5	7–10
style division	bifid for 1/3–1/2 of their length	entire	entire or scarcely bifid at the tip
capsule size (mm)	1.5–1.8 × 1.7–2.2	1.1–1.3 × 1.3–1.5	1.7–1.8 × 1.7–2.2
seed length (mm)	1–1.3	0.7–0.8	1–1.2

The name *Euphorbia drummondii* has often been applied to this species in the past. *E. albrechtii* differs in having larger gland appendages 0.2–0.4 mm long (versus <0.1 mm long for *E. drummondii*), capsules that are broadest towards the base and acutely keeled (versus broadest towards the equator and obtusely keeled for *E. drummondii*), more robust habit, and seeds with surfaces irregularly ridged (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*).

***Etymology*:** The species is named in honour of botanist David E. Albrecht, Alice Springs Herbarium (1993–2012), who has made significant contributions to our knowledge of the flora of Central Australia.

3. Euphorbia armstrongiana Boiss., in A.DC., *Prodr.* 15(2): 47–48 (1862). **Type:** [Northern Territory.] Port Essington, *s.d.*, [*J.W.*] *Armstrong 530* (lecto [here designated]: K 186465 [ex Herb. Hook.]; isolecto: K 186464 [ex Herb. Benth.]).

Monoecious, annual with lax habit to 60 cm high, few to several stems arising from slender taproot. **Stems** decumbent to erect (rarely prostrate, *Lazarides & Adams 146* [DNA]), sparingly to much branched, smooth, glabrous or sparsely to moderately pilose with spreading white hairs 0.7–2.5 mm long. **Interpetiolar stipules** triangular, 0.3–0.6 mm long, entire or deeply bipartite to base, glabrous adaxially, hairy abaxially with straight stiff white hairs to 0.3 mm long; margin entire or laciniate. **Leaves**: petiole 1–2.3 mm long, smooth, glabrous or with indumentum as for stems; blade oblong, elliptic or occasionally broad-elliptic to rotund, 7–20 mm long, 5–10 mm wide, 1–2.2 times longer than wide; both surfaces smooth; adaxial surface green occasionally with reddish tinge, glabrous; abaxial surface pale green, glabrous or sparsely pilose with spreading, ± straight hairs 0.9–1.1 mm long; base asymmetric with one side cordate, the other obtuse to rounded; margin entire or sparingly minutely toothed, sometimes only proximally; apex rounded to obtuse, sometimes minutely apiculate. **Cyathia** solitary at the upper nodes; peduncles 1–3.5 mm long. **Involucres** cupuliform, 0.9–1.4 mm long, 1.3–1.8 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin fimbriate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, 0.4–0.6 mm long, 0.6–1.1 mm wide, pale green; gland appendages conspicuous to inconspicuous, spreading radially, transverse-linear or lunate, 0.1–0.25 mm long, 0.9–1.3 mm wide, white or occasionally pink, glabrous, margin ± entire; bracteoles 0.8–1 mm long, adnate for *c.* 1/2 of their length to involucre, free portion divided into numerous ± linear hairy segments. **Staminate flowers** 18–22 per cyathium; pedicels 1.3–1.5 mm long; staminal filaments 0.4–0.5 mm long. **Pistillate flowers**: styles 0.7–0.9 mm long, connate at the base into a column for *c.* 1/4 of their length, erect, recurved distally, smooth, glabrous, each bifid for *c.* 1/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 5 mm long, very broad-ovate in lateral view, 2.5–3 mm long, 2.8–3.8 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** broad-ovate in outline, 1.6–1.9 mm long, 1.2–1.4 mm tangentially, 1.1–1.4 mm radially, tetragonous in cross section; dorsal and ventral faces ± planar, with 4–6 distinct transverse grooves; exotesta thin, ± of even thickness over surface, pale brown or pale grey, micropapillate, not becoming mucilaginous when moistened; endotesta red-brown.

Distribution: *Euphorbia armstrongiana* extends from the Kimberley region, WA to north-western NT.

Typification: In his protologue of *E. armstrongiana,* Boissier (1862) states “Ad Port. Essington Australiae tropicae (Armstrong n. 530!)..(v.s. in h. Kew.)”. Two sheets of the Armstrong collection have been located amongst material on loan to BRI from K, and are numbered (186464 ex Herbarium Benthamianum 1854) and (186465 ex Herbarium Hookerianum 1867) respectively. The specimen numbered 186465 is selected here as lectotype of *E. armstrongiana* as it is part of the original material, morphologically agrees with the protologue description and is the more ample of the two specimens.

Notes: *Euphorbia armstrongiana* is easily distinguished from all other species of *E.* sect. *Anisophyllum* in Australia by its very distinctive seed sculpturing and generally slender stems with elongated internodes. The seed surface is sulcate with 4–6 distinct transverse grooves (**Fig. 25B**).

As circumscribed here, *E. armstrongiana* exhibits discontinuous variation in branchlet indumentum associated with a geographical disjunction. These taxa are here recognised as varieties which can be distinguished using the following key.

Key to varieties of *Euphorbia armstrongiana*

Stems hairy, sometimes only proximally . . . . . . **3a. E. armstrongiana** var. **armstrongiana**
Stems glabrous . . . . **3b. E. armstrongiana** var. **distans**

3a. Euphorbia armstrongiana var. armstrongiana

***Illustration*:** Dunlop *et al.* (1995: 218, fig. 72).

Stems with a sparse to moderately dense indumentum of spreading, ± straight, white hairs 0.7–2.5 mm long.

***Additional selected specimens examined*:** **Northern Territory.** Cobourg Peninsula, Smith Point, Mar 2002, *Risler & Firth 1773* (DNA); *c.* 25 km NE of Jabiru, Mar 1981, *Craven 6608* (AD, BRI, DNA); 10 km S of Oenpelli, Arnhem Land, May 1988, *Munir 5831* (AD); Litchfield N.P., Mar 1995, *Cowie 5323 & Taylor* (BRI); Mary River, May 1989, *Clarke 1776* (BRI); *c.* 6 miles [*c.* 10 km] N of Pine Creek township, Mar 1965, *Lazarides & Adams 146* (DNA, NSW); UDP [Gunlom] Falls, 108 km NE of Pine Creek (Waterfall Creek N.R.), May 1983, *Barker 506* (AD, NSW); Kakadu N.P., 19.1 km S of old Darwin road, along road to Pine Creek, Apr 1992, *Halford Q1124* (BRI); Kakadu Stage 3, Kambolgie Creek, Apr 1993, *Egan 2129* (BRI, DNA); Edith River area, Apr 1999, *Michell & Risler 2339* (DNA).

***Distribution and habitat*:** *Euphorbia armstrongiana* var. *armstrongiana* occurs in north-western NT, in an area more or less bounded by the Cobourg Peninsula, Oenpelli, Katherine and Litchfield N.P. (**Map 3a**). It grows in eucalypt woodland/forest communities sometimes in *Allosyncarpia* forest communities on sandy soils mostly derived from sandstone. It is commonly found amongst boulders on sandstone plateaux, scree slopes, rocky hillsides or rocky crevices.

***Phenology*:** Flowers and fruits have been collected from March to May.

3b. Euphorbia armstrongiana var. **distans** (W.Fitzg.) Halford & W.K.Harris **combinatio et status nova**; *Euphorbia distans* W.Fitzg., *J. & Proc. Roy. Soc. Western Australia* 3: 160 (1916). **Type:** Western Australia. Mount Broome, May 1905, *W.V.Fitzgerald 818* (lecto [here designated]: PERTH 2847248; isolecto: NSW 98807).

***Illustration*:** Wheeler (1992: figs 183C, 184F, 185F, 186F), as *Euphorbia distans*.

Stems glabrous.

***Additional selected specimens examined*:** **Western Australia.** West Governor Island, Napier Broome Bay, May 1984, *Willis s.n.* (MEL 296755); West Montalivet Island, Bonoparte Archipelago, Jun 1992, *Kenneally 11216* (PERTH); 'Shelly Beach Island' in Prince Frederick Harbour, May 1987, *Kenneally 10008* (PERTH); fire plot 2, 15 km W of airstrip on Mitchell Falls track, Mitchell Plateau, Oct 1981, *Farrell 953* (PERTH); creek entering inlet of Talbot Bay, 23 km SE of Cockatoo Island, May 1983, *Fryxell & Craven 3889* (PERTH); Long Island, Buccaneer Archipelago, Jun 1982, *Hopkins BA136* (PERTH); Sunday Island, Buccaneer Archipelago, Jun 1982, *Hopkins BA7* (PERTH); Barker River Gorge, 4 km N of Mt Hart Station homestead, King Leopold Ranges, Jun 1988, *Edinger 611* (PERTH); Yellow Man Creek, 10 km NE of Mount Hart homestead, May 1998, *Kenneally 12145* (PERTH); Fern Creek, King Leopold Range, 1.3 km W of Mt Bell, May 1988, *Cranfield 6723* (PERTH).

***Distribution and habitat*:** *Euphorbia armstrongiana* var. *distans* occurs in the Kimberley, WA, from Bonaparte Archipelago south to King Leopold Range (**Map 3b**). It grows in woodland communities along creeks, on hillslopes or on flat terrain on clay to sandy soils derived from granite, sandstone or basalt. It is also found growing in rock crevices in vine thicket communities and amongst coastal rocks on beach conglomerate or beach sand.

***Phenology*:** Flowers and fruits have been collected from April to July with one collection in October.

***Typification*:** Fitzgerald (1918) based his description of *Euphorbia distans* on material he collected from near Mt Broome in the Kimberley, WA. Two sheets of a collection made by Fitzgerald from Mt Broome have been located amongst material on loan to BRI from PERTH [2847248] and NSW [98807]. The sheet numbered 2847248 from PERTH is here chosen as lectotype because it is the best preserved and more ample of the two specimens and morphologically agrees with the protologue description of this species.

4. Euphorbia australis Boiss., *Cent. Euphorb.* 15 (1860); *Chamaesyce australis* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Western Australia.] baie des chiens marins [bay of the sea dogs (Shark Bay)], [September 1818], *C.Gaudichaud 1400* (holo: G-DC [G 149371] *n.v.* (image seen) (IDC microfiche 800-73. 2421: III. 1); iso: P 313100).

Monoecious, herbaceous perennial to 30 cm high, few to many stems arising from thickened taproot. **Stems** prostrate, ascending to erect, much branched, smooth, with a sparse to dense indumentum; hairs spreading, ± straight, 0.1–0.9 mm long, white. **Interpetiolar stipules** narrow-triangular, 0.5–1 mm long, deeply bipartite, with indumentum as for stems; margin laciniate. **Leaves**: petiole *c.* 1 mm long, smooth, indumentum as for stems; blade oblong, obovate or oblong-elliptic, 4–16 mm long, 2–9 mm wide, 1.5–2.4 times longer than wide; adaxial surface green or red, smooth or minutely papillose, glabrous or with a sparse to dense indumentum consisting of ascending to spreading, ± straight hairs, 0.1–0.8 mm long; abaxial surface green or red, minutely papillose, with a sparse to dense indumentum as for abaxial surface; base asymmetric with one side cordate the other rounded; margin entire or toothed distally; apex rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves smaller than the primary stem leaves; peduncles 0.6–0.7 mm long. **Involucres** turbinate, 0.9–1.2 mm long, 0.9–1 mm across; lobes 5, triangular, 0.3–0.6 mm long, margin entire or ciliate; glands 4, stipitate, patelliform or cupuliform, concave or with shallow central pit, transverse-oblong or transverse-elliptic in outline, 0.1–0.3 mm long, 0.3–0.6 mm wide, red or yellow; gland appendages conspicuous to inconspicuous, spreading radially, transverse-oblong to obdeltoid, 0.1–0.4 mm long, 0.3–0.9 mm wide, red or yellow or creamy white, glabrous; margin dentate or irregularly lobed; bracteoles 0.5–1 mm long, adnate for *c.* 1/5 of their length to involucre, free portion entire or divided into numerous ± subulate glabrous or hairy segments. **Staminate flowers** 5–10 per cyathium; pedicels 1–1.2 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.3–0.6 mm long, spreading and recurved distally, smooth, glabrous, bifid for 1/3–2/3 of their length, with apices terete. **Capsules** exserted from involucre on pedicel to 2 mm long, ± broad-elliptic in lateral view, 1.4–2 mm long, 1.5–2.1 mm across, shallowly 3-lobate with keels obtuse, smooth or minutely papillose, with a moderately dense to dense indumentum; hairs spreading, 0.1–0.7 mm long; hypogynous disc entire. **Seeds** broad-ovate in outline, 0.8–1.6 mm long, 0.6–0.9 mm tangentially, 0.6–0.9 mm radially, tetraquetrous in cross section; dorsal faces planar or convex; ventral faces planar or concave; all faces faintly to distinctly irregularly ridged or undulate; exotesta thin, of even thickness over surface, grey-white or brown, microreticulate, mostly becoming mucilaginous when moistened; endotesta red-brown.

Distribution and habitat: *Euphorbia australis* is widespread across the arid zone of Australia occurring in all mainland States excluding Vic.

Notes: *Euphorbia australis* is consistently hairy on most parts. It is most similar to *E. careyi*, *E. centralis* and *E. vaccaria.* For features distinguishing *E. australis* from those species, refer to the 'Notes' section under the species concerned.

As circumscribed here, this species is a morphologically variable complex that exhibits a wide range of variation in habit and length of indumentum, as well as variations in size of seeds, degree of serration of the leaf margin and degree of lobing on gland appendages. Four varieties are here formally recognised which can be distinguished using the following key.

Key to varieties of *Euphorbia australis*

1 Upper surface of leaf blades glabrous or rarely with a few scattered hairs . . . . **4c. E. australis** var. **glabra**
1. Upper surface of leaf blades sparsely to densely hairy **2**

2 Leaf margins entire; plants moderately to densely villose; seeds ≤1.3 mm long . . . .**4e. E. australis** var. **subtomentosa**
2. Leaf margins toothed sometimes only distally; plants hispid to hispidulous, pilose or sparsely to densely villose; seeds 1–1.6 mm long **3**

3 Plants hispid to hispidulous; hairs on capsules mostly ≤0.3 mm long; dorsal faces of seed faintly irregularly ridged or undulate . **4d. E. australis** var. **hispidula**

3. Plants villose or pilose; hairs on capsules >0.3 mm long; dorsal faces of seed distinctly irregularly ridged **4**

4 Plants pilose to villose; leaf blades 9–16 mm long by 3–9 mm wide; cyathia mostly green; glands yellow to red; gland appendages often white to creamy yellow, shallowly lobed or toothed; grows in coastal and subcoastal areas . . . . **4a. E. australis** var. **australis**

4. Plants villose; leaf blades 3.2–8 mm long by 2–5 mm wide; cyathia and glands red; gland appendages red, usually acutely toothed; grows in arid inland areas . . . . **4b. E. australis** var. **erythrantha**

4a. Euphorbia australis var. australis

Herb to 10 cm high; stems usually prostrate, rarely ascending. Indumentum pilose to villose; hairs (0.2) 0.6–0.9 mm long. **Leaves** oblong to oblong-elliptic, 9–16 mm long, 3–9 mm wide, margin toothed distally, adaxial and abaxial surfaces pilose to villose. **Involucres** mostly green; glands 0.1–0.3 mm long, 0.3–0.5 mm wide, yellow to red; appendages transverse-oblong to obdeltoid, 0.1–0.2(0.4) mm long, 0.2–0.5(0.9) mm wide, shallowly to deeply lobed, mostly white to creamy yellow. **Capsules** 1.5–1.8 mm long, 1.8–2 mm wide; hairs 0.4–0.5 mm long. **Seeds** 1.1–1.6 mm long, 0.6–0.9 mm tangentially, 0.6–0.9 mm radially, with distinct irregular ridges on dorsal faces.

Additional selected specimens examined**: Western Australia.** Varanus Island, Lowendale Group, May 1991, *Thomson 3500* (DNA); Barrow Island, Oct 1980, *Buckley 6731* (PERTH); Sandy Island, Flying Foam Passage, Dampier Archipelago, May 1960, *Royce 6386* (PERTH); Burrup Peninsula, May 1991, *Thomson 3508* (PERTH); between Port Hedland & Mundabullangana Station, Feb 1962, *George 3345* (PERTH); Thevenard Island, W of Onslow, May 1960, *Royce 6367* (PERTH); North West Cape, Aug 1960, *George 1385* (PERTH); near Norcape Lodge, Exmouth, Jul 1977, *McFarland 2* (BRI, PERTH); Beagle Island, 50 miles [*c.* 80 km] NE of Onslow, May 1960, *Royce 6375* (PERTH); Ward Reef road due north of C platform, Thevenard Island, May 1990, *White MRW040* (PERTH); Thevenard Island, Jun 1988, *Long VL260* (DNA); Bay of Rest, William Preston Point, Exmouth Gulf, Aug 1980, *Kenneally 7377* (PERTH); 21 miles [*c.* 34 km] S of Learmonth, Jun 1961, *George 2447* (PERTH); 23 miles [*c.* 37 km] S of Learmonth, Aug 1960, *George 1264* (PERTH); 63 miles [*c.* 101 km] S of Learmonth, Aug 1960, *George 1426* (PERTH); 12 km E of Cape Cuvier, N of Carnarvon, Aug 1995, *Keighery & Gibson 883* (PERTH); Carnarvon – Quobba Road, *c.* 33 km N of Carnarvon, Jul 1969, *Wilson 8376* (PERTH); Carnarvon on Gascoyne River bank, May 1995, *Cranfield 9682* (PERTH); Shark Bay, Peron Peninsula, S of Carnarvon, Sep 1940, *Blackall 4644* (PERTH); Bundegee Wash, Sep 1998, *Mitchell-Smith 41* (PERTH).

Distribution and habitat**:** *Euphorbia australis* var. *australis* occurs on the islands and coastal and subcoastal parts of north-western WA from near Port Hedland south to Peron Peninsula, Shark Bay (**Map 4a**). It grows on sandy soils on foreshores, coastal sandhills, creek banks or alluvial plains.

Phenology**:** Flowers and fruits have been collected sporadically throughout the year mostly from May to August.

4b. Euphorbia australis var. erythrantha

(F.Muell.) Benth., *Fl. Austral.* 6: 48 (1873); *Euphorbia erythrantha* F.Muell., *Fragm.* 2: 152 (1861). **Type:** [New South Wales.] Barrier Range, [1860] Vict. Exped. [*H.Beckler s.n.*] (lecto [here designated]: MEL 1560386; isolecto: MEL 1560385).

Herb to 10 cm high; stems usually prostrate, rarely ascending to erect. Indumentum villose; hairs (0.2) 0.6–0.9 mm long. **Leaves** oblong, suborbicular to obovate, 3.2–8 mm long, 2–5 mm wide, margin toothed distally, adaxial and abaxial surfaces villose. **Involucres** mostly red; glands 0.1–0.2 mm long, 0.3–0.6 mm wide, red; appendages obdeltoid, 0.1–0.2(0.4) mm long, 0.2–0.5(0.9) mm wide, shallowly to deeply toothed, red. **Capsules** *c.* 1.8 mm long and 2 mm wide; hairs 0.4–0.6 mm long. **Seeds** with faint to distinct irregular ridges on dorsal faces, 1.2–1.6 mm long, 0.7–0.8 mm tangentially, 0.7–0.9 mm radially. $n = 11$.

***Additional selected specimens examined*:** **Western Australia.** near Lake Hopkins, Jul 1967, *George 8895* (PERTH); Elder Creek, 2 miles [*c.* 3 km] W of Warburton, Aug 1962, *George 3830* (PERTH); Mt Eveline, E of Warburton, Aug 1962, *George 3886* (PERTH); just to N of Blackstone Range, Jun 1977, *Burbidge 20/77 & Fuller* (PERTH). **Northern Territory.** Thomas Reservoir, Apr 1987, *Thomson 1715* (DNA). **South Australia.** Evelyn Creek, *c.* 11 km E of Mt Willoughby homestead, Sep 1966, *Shaw 513* (AD); Evelyn Downs, Sep 1955, *Ising* (AD 966150252); 55 km S of Mt Willoughby homestead, May 1984, *Badman 1095* (AD); Balcanoona, near Nudlamutana Well, Oct 1967, *Eichler 19623* (AD); Arkaroola Station, Sep 1971, *Kuchel 2936* (AD); Mt Chambers, Oct 1975, *Whibley 5623* (AD); Paralana Hot Springs, Nov 1993, *Bates 35069* (AD); Mount Harper Island, Apr 1993, *Bates 31973* (AD); *c.* 3 km E of Aroona Dam, Sep 1972, *Lothian 5229* (AD). **New South Wales.** 9 miles [*c.* 14 km] N of Silverton, May 1973, *Hassall 7314* (BRI); Broken Hill, Sep 1919, *Morris 7* (BRI); McDougalls Well, N of Broken Hill, Mar 1972, *Milthorpe 708* (NSW); Mundi Mundi Creek, May 1979, *Fox 7905006* (NSW); Conservation paddock, Fowler's Gap Station, *c.* 16 km SSW of Lake Bancannia, Aug 1973, *Cunningham 1345 & Milthorpe* (NSW); back paddock, Gnalta Station, 95 miles [*c.* 153 km] NE of Broken Hill, Sep 1973, *Cunningham 1197 & Milthorpe* (NSW).

***Distribution and habitat*:** *Euphorbia australis* var. *erythrantha* occurs in the southern arid zone where it extends from Warburton, WA, through SA to White Cliffs, in western NSW (**Map 4b**). It grows mostly in bare open areas or in open shrubland communities on rocky or stony slopes of sandstone, limestone or granite, stony plains, or in rock crevices on breakaway cliffs. The soils are mostly skeletal to shallow red brown clay loams, clays or occasionally sands.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Typification*:** In the protologue of *Euphorbia erythrantha*, Mueller (*loc. cit.*) cited "In deserto circum montes Barrier Range. Dr Beckler". Two sheets considered to be part of the collections used by Mueller have been located in material on loan to BRI from MEL, **a:** "near Barrier Range, Beckler" [MEL 1560385]; **b:** "Barrier Range, Vict. Exped." [MEL 1560386]. Both sheets have a blue label attached with the name *E. erythrantha* written in Mueller's hand. The material on these sheets agrees with the description in the protologue and it is considered to be type material. Sheet MEL 1560386 is chosen as the lectotype for *E. erythrantha* because it is the more ample specimen.

Dr Hermann Beckler was the medical officer and botanist to the original Burke and Wills, Victorian Exploration Expedition in 1860. Willis (1962) noted that Beckler never reached the Barrier Range and that Mueller and Bentham incorrectly assign many of Beckler's collections from the Scrope Range (*c.* 90 km E of the Barrier Range) to this locality.

***Notes*:** *Euphorbia australis* var. *erythrantha* is similar to *E. australis* var. *subtomentosa* with its villose indumentum and red cyathia, glands and gland appendages. It differs in having toothed leaf margins and mostly acutely toothed gland appendages.

It can be difficult to distinguish between *E. australis* var. *erythrantha* and some forms of *E. centralis* with which it is sympatric in parts of eastern WA and northern SA. For features distinguishing *E. australis* var. *erythrantha* from *E. centralis*, refer to the 'Notes' section under that species.

4c. Euphorbia australis var. **glabra** Halford & W.K.Harris, **varietas nova** arcte similis *E. australi* var. *subtomentosae* Domin quoad indumentum et formam foliorum. Ab omnibus aliis varietatis *E. australis* superficie foliorum supra glabris differt. **Typus:** Western Australia. Hamersley Range National Park, 4.2 km along Mt Bruce homestead (abandoned) track from Marandoo East Road, 14 May 1980, *M.Trudgen 2579* (holo: PERTH; there are three unmounted duplicates (isotypes) with the holotype sheet).

Herb; stems prostrate. Indumentum pilose; hairs 0.4–1.3 mm long. **Leaf blades** elliptic to broadly elliptic, 3–8 mm long, 2–6 mm wide, margin entire; adaxial surface glabrous or rarely with a few scattered pilose hairs; abaxial surface pilose. **Involucres** mostly green; glands 0.1–0.2 mm long, 0.3–0.6 mm wide, pale green or red; appendages transverse-oblong or obdeltoid, 0.2–0.3 mm long, 0.5–0.6 mm wide, entire, mostly pink. **Capsules** 1.7–2 mm long, 1.6–2.1 mm wide; hairs 0.5–0.7 mm long. **Seeds** with low faint irregular ridges on dorsal faces, 1.4–1.5 mm long, 0.7–0.8 mm tangentially, 0.8–0.9 mm radially.

***Additional specimens examined*: Western Australia.** Erallinga Pool, Hamersley Ranges, Apr 1997, *Trudgen MET18971* (PERTH); Caves Creek, Mt Brockman Road, 50 km W of Hamersley Station homestead, Sep 2006, *Halford Q9256A* (BRI); Karijini N.P., Mt Bruce Flats, 13 km E of Marandoo Hill, 7.3 km SE of Mt Bruce, 9.3 km S of Mt Oxer, 5.7 km W of Mt Howieson, Hamersley Range, Mt Bruce S, Sep 1998, *van Leeuwen 3861* (BRI).

***Distribution and habitat*:** *Euphorbia australis* var. *glabra* is restricted to the Hamersley Range, Pilbara, WA where it is known only from a few scattered localities (**Map 4c**). It grows on banks of semi-permanent pools or creeklines, or alluvial flats, in *Eucalyptus camaldulensis* Dehnh. open forest or *E. victrix* L.A.S.Johnson & K.D.Hill low forest on sandy to clayey-loam alluvium.

***Phenology*:** Flowers and fruits have been collected from April to June and September.

***Notes*:** *Euphorbia australis* var. *glabra* is most similar to *E. australis* var. *subtomentosa* in indumentum and leaf shape. It differs from all varieties of *E. australis* by its glabrous upper leaf surface.

***Etymology*:** The varietal epithet is from Latin *glaber*, glabrous, in reference to the lack of indumentum on the adaxial surface of the leaves of this variety.

4d. Euphorbia australis var. **hispidula** Halford & W.K.Harris, **varietas nova** ab aliis varietatis *E. australis* differt a combinatiore characterum sequente: indumentum caulium foliorum capsularum undique hispidulosum usque hispidum, margines foliorum distale dentatae, pili in capsulis usque 3 mm longis, superficies dorsales seminum porcatae leviter irregulariter vel undulatae. **Typus:** Western Australia. Mt Nameless, near Tom Price, 22 September 2006, *D.Halford Q9240* (holo: BRI; iso: MEL, PERTH, *distribuendi*).

Herb to 30 cm high; stems prostrate, rarely ascending to erect. Indumentum on stem and leaves hispidulous to hispid, moderately dense with hairs 0.1–0.6 mm long. **Leaves** oblong, oblong-elliptic or oblong-obovate, 4–10 mm long, 2–6 m wide; margin toothed distally. **Involucres** mostly red; glands *c.* 0.1 mm long, 0.2–0.3 mm wide; gland appendages transverse-oblong, shallowly to deeply lobed, 0.1–0.2 (0.4) mm long, 0.2–0.5(0.9) mm wide. **Capsules** 1.4–1.9 mm long, 1.5–2.1 mm wide; hairs 0.1–0.3 mm long. **Seeds** faintly irregularly ridged or undulate, 0.9–1.2 mm long, 0.6–0.8 mm tangentially, 0.6–0.8 mm radially.

***Additional selected specimens examined*: Western Australia.** Djaluwon Creek, near S end of Lake Gregory, Apr 1979, *George 15376* (PERTH); 27 miles [*c.* 43 km] N of Lookout Rocks, May 1947, *Royce 1855* (PERTH); 10.9 km S of the Mt Bruce turnoff on the Wittenoon to Nanutarra Road, Sep 1991, *Trudgen MET10610 & Maley* (PERTH); Mt Nameless, near Tom Price, Jul 1980, *Atkins 838* (PERTH); *c.* 35 km W along Mt Brockman Road from Hamersley Station homestead, Sep 2006, *Halford Q9259* (BRI); 6 km W of Mujina Claypan, and 20 km ENE of Mt Windell, Feb 1987, *Mollemans 2306* (AD, PERTH); Hamersley Range N.P., 16.4 km from Milli Milli Springs on the track to Coppin Pools, May 1980, *Trudgen 2443/a* (PERTH); 3.25 km WSW of Packsaddle Hill, Hamersley Ranges, Jul 1997, *Trudgen 16711* (PERTH); 21 km N of Juna Downs homestead, Aug 1973, *Trudgen 380 & Merton* (PERTH); Hamersley Range N.P., above Dales Gorge, Aug 1974, *Carr 4823 & Beauglehole 48601* (NSW); *c.* 45 km NE of Tom Price along Karijini Drive, W of Marrandoo, Sep 2006, *Halford Q9207* (BRI). *c.* 30 km W along Karijini Drive from Ranger Station, Karijini N.P., Sep 2006, *Halford Q9201* (BRI); 4.5 km SSE of West Angela Hill, Hamersley Ranges, Jul 1997, *Trudgen 16723* (PERTH); Little Sandy Desert, Apr 1979, *Mitchell 579* (DNA, PERTH); Little Sandy Desert, Apr 1979, *Mitchell 663* (PERTH). **Northern Territory.** 7 km NW [of] Tanami Mine, Sep 1990 *Latz 11821* (MEL, NT); Warrego, May 1993, *Egan 2214* (DNA); Tennant Creek, Mary Ann Dam, May 1993, *Egan 2267* (DNA); 35.5 miles [*c.* 57 km] NNW of Wauchope township, Aug 1956, *Lazarides 5850* (MEL, NSW); Devil's Marbles, Jun 1955, *Chippendale 1912* (DNA, NSW).

***Distribution and habitat*:** *Euphorbia australis* var. *hispidula* occurs from near Tom Price, Pilbara, WA to Tennant Creek, NT (**Map 4d**). It grows in open *Triodia* grassland or *Acacia*/mallee shrubland with *Triodia* sp. in the understorey on skeletal stony or gravelly clay loams on ironstone hills or ridges, or on sandy to loam soils on sandplains.

***Phenology*:** Flowers and fruits have been collected from April to October.

***Notes*:** *Euphorbia australis* var. *hispidula* differs from the other varieties of *E. australis* by the following combination of characters: the indumentum is hispidulous to hispid on stems, leaves and capsules, leaf margins toothed distally, hairs on capsules up to 0.3 mm long and dorsal faces of seeds faintly irregularly ridged or undulate.

Etymology**:** The varietal epithet is from Latin *hispidus*, hispid (covered with erect, rigid hairs), in reference to the indumentum on most surfaces of the variety.

4e. Euphorbia australis var. **subtomentosa** Domin, *Biblioth. Bot.* 89(4): 310 (1927 '1926'). **Type:** Western Australia. Inter Ashburton et De Gray River *s.d.*, *E.Clement s.n.* (holo: PR 528303; iso: K 186467, 186468).

Herb to 20 cm high; stems usually prostrate, rarely ascending to erect. **Indumentum** sparsely to densely villose; hairs 0.1–0.9 mm long. **Leaves** oblong, suborbicular to obovate, 2.5–7 mm long, 2–4 mm wide, margin entire, adaxial and abaxial surfaces villose. **Involucres** mostly red; glands 0.–0.25 mm long, 0.1–0.4 mm wide, red or yellow; gland appendages transverse-oblong, 0.1–0.3 mm long, 0.3–0.4 mm wide, shallowly to deeply toothed, red, yellow or white. **Capsules** 1.4–1.8 mm long, 1.4–1.8 mm wide; hairs 0.5–0.8 mm long. **Seeds** with faint to distinct irregular ridges on dorsal faces, 0.8–1.3 mm long, 0.5–0.6 mm tangentially, 0.5–0.6 mm radially. *n* = 11. **Fig. 25C**.

Additional selected specimens examined**: Western Australia.** just W of Wolf Creek Crater, Apr 1979, *George 15312* (PERTH); Meentheena Station Conservation Reserve, 12.7 km ESE of Bullgarina Hill, 7.3 km ESE of King Rock Hole, 30 km E of Mt Edgar, 25.8 km N of Baroona Hill, May 2000, *van Leeuwen 4497* (BRI, PERTH); 4 km SW of Two Sisters, *c.* 145 km SE of Shay Gap, Jul 1984, *Newbey 10481* (PERTH); Hamersley Range N.P., just S of Marandoo Ridge near entrance to 'Grimace Gulch', Sep 1978, *Trudgen 2253* (PERTH); Hamersley Range N.P., 0.3 km from Mindi Springs on track to Juna Downs, Mar[?] 1980, *Trudgen 2616* (PERTH); Rudall River, Aug 1971, *Wilson 10308* (PERTH); Rudall River, May 1971, *George 10641* (PERTH); Turee Creek, Turee Station, *c.* 40 km E of Paraburdoo, Sep 2006, *Halford Q9233A* (BRI); Jacobs Creek Gully, May 1995, *Cranfield 9701* (PERTH); 1 km NE of Thompsons Mill, Mt Gould Station, May 1986, *Cranfield 5434* (PERTH); *c.* 5 km NE of Wellington Range on road from Wiluna to Carnegie homestead, Sep 1984, *Wilson 11975* (PERTH). **Northern Territory.** Bunda Station, Jun 1994, *Egan 4215* (DNA); Wave Hill Station, Mar 1997, *Michell 634 & Mangion* (DNA); Supplejack Station, 38 km W of homestead, Sep 1970, *Henshall 2329* (DNA); Kings Canyon, 1.5 km W [of] George Gill Range, Jul 1981, *Thomson 74* (DNA). **Queensland.** BURKE DISTRICT: 251.7 km S of Normanton, May 1976, *Hassall 7638* (BRI); 63.5 km by road S of Burke & Wills Roadhouse on Burke Development Road, Mar 2005, *McDonald KRM4131* (BRI); 12 km NE of Mt Isa, May 1983, *Schmid 673* (BRI); Cloncurry –Normanton road, 8.1 km N of Quamby, Jun 1999, *Bean 15172* (BRI); 20 km W of Cloncurry, on road to Mount Isa, Jun 1991, *Halford Q443* (BRI, MEL).

Distribution and habitat**:** *Euphorbia australis* var. *subtomentosa* is widespread in inland WA extending across the NT to western Qld (**Map 4e**). It grows in *Triodia* grassland, *Acacia*/eucalypt woodland communities on skeletal to shallow gravelly sand to clay soils on plains, alluvial flats or rocky hills.

Phenology**:** Flowers and fruits have been collected from January to October.

Notes**:** *Euphorbia australis* var. *subtomentosa* is similar to *E. australis* var. *erythrantha*. For features distinguishing of *E. australis* var. *subtomentosa* from *E. australis* var. *erythrantha*, refer to the 'Notes' section under that variety.

As circumscribed here *E. australis* var. *subtomentosa* has two distinct forms. Though the extremes of these variants are distinctive they do merge into one another with numerous intermediates in the Pilbara region where their distributions overlap. The two forms are as follows:

Typical form: Stems prostrate, usually red in colour, hairs on stems >0.4 mm long; leaves pale green often with red blush over surfaces or red tinge along margins; cyathia usually red rarely grey-green, seeds 1–1.3 mm long. This is common throughout the western part of the range for this variety (e.g. *Cranfield 5434*, *9701*, *Trudgen 2253*).

Eastern form: Stems ascending to erect or prostrate, grey-green rarely red in colour, hairs on stems mostly ≤0.4 mm long; leaves mostly grey-green in colour; cyathia mostly grey or grey-green rarely red, seeds 0.8–1 mm long. This is common in north-western Qld but extends to the Kimberley and the Pilbara region, WA (e.g. *Egan 4215*, *George 15312*, *Hassall 7638*).

5. Euphorbia biconvexa Domin, *Biblioth. Bot.* 89(4): 308 (1927 '1926'); *Chamaesyce biconvexa* (Domin) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** Queensland. [Cook District:] apud opp. Mungana, in colle calcareo, February 1910, *K.Domin s.n.* (holo: PR 528286).

Illustration: Weber (1986: 749, fig. 401B), as *E. coghlanii.*

Monoecious, annual or herbaceous perennial with short-lived stems produced from thick cylindrical taproot, to 80 (100) cm high, few to many stems arising from rootstock. **Stems** ascending to erect (rarely prostrate), sparingly to much branched, smooth, glabrous or rarely sparsely pilose with ± spreading white hairs 0.2–1 mm long. **Interpetiolar stipules** narrow-triangular, 0.6–1.5 mm long, bifid or deeply bipartite, glabrous; margin laciniate (rarely entire). **Leaves**: petiole 0.7–1 mm long, smooth, glabrous; blade oblong, narrow-ovate or ovate, sometimes falcate, 8–36 mm long, 2.5–9 mm wide, 2–6 times longer than wide; adaxial surface green to dark green or glaucous, sometimes with reddish tinge on margin, smooth, glabrous; abaxial surface paler than adaxial surface, smooth, glabrous or rarely sparsely pilose with spreading, crispate hairs to 1 mm long; base asymmetric with one side cordate, the other rounded to cordate; margin entire or serrulate distally; apex acute to obtuse or rounded. **Cyathia** solitary at the upper nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves smaller than the primary stem leaves; peduncles 1–2 mm long. **Involucres** turbinate, 0.8–1 mm long, 0.9–1.1 mm across; lobes 5, triangular or subulate, 0.3–0.5 mm long, margin entire or laciniate; glands 4, stipitate, patelliform, planar or concave, transverse-oblong or orbicular in outline, 0.1–0.2 mm long, 0.1–0.4 mm wide, yellowish green; gland appendages conspicuous, spreading radially, broad-obovate or reniform, 0.2–0.4 mm long, 0.3–0.8 mm wide, white (rarely red), glabrous, margin entire; bracteoles 0.8–1 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** 1–15 per cyathium; pedicels *c.* 0.9 mm long; staminal filaments 0.3–0.4 mm long. **Pistillate flowers**: styles 0.4–0.5 mm long, spreading to erect, recurved distally, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, transversely broad-elliptic in lateral view, 1.6–2 mm long; 2–2.5 mm across, deeply 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** narrow-ovate or elliptic in outline, 1–1.5 mm long, 0.5–0.9 mm tangentially, 0.9–1.1 mm radially, laterally compressed, biconvex in transverse section; faces convex, smooth; exotesta thin, of even thickness over surface, pale grey, microreticulate, becoming mucilaginous when moistened; endotesta brown. $n = 8$. **Fig. 25D.**

***Additional selected specimens examined*: Western Australia.** Djaluwon Creek, near S end of Lake Gregory, Apr 1979, *George 15384* (PERTH); Mt Windell road corridor, 8 km NW of Mt Windell, 3.6 km ESE of Karijini N.P. headquarters, Mar 1992, *van Leeuwen 1105* (PERTH); Hamersley Range N.P., *c.* 0.5 km S from Dales Gorge turnoff, on Yampire Gorge – Juna Downs homestead road, Aug 1977, *Jackson 2938* (AD, MEL); 25 miles [*c.*40 km] S of Sir Frederick Range, Aug 1962, *Symon 2289* (AD); Wooramel River crossing, Innouendy Station, May 1995, *Cranfield 9733* (PERTH); 30 km S [of] Karratha, May 1991, *Thomson 3501* (DNA). **Northern Territory.** Cutta Cutta Caves Reserve, Feb 1989, *Thomson 3271* (DNA); 2 km S of Daly Waters on the Stuart Highway, Feb 1988, *Thomson 2235* (BRI); 22 km N [of] Ucharonidge homestead, Feb 1989, *Thomson 3247* (BRI); 5 km NW of Wycliffe Well, May 1983, *Halford 83536* (DNA); Palm Valley, Sep 1958, *Chippendale 4912* (AD, DNA, MEL); Uluru (Ayres Rock – Mt Olga) N.P., Kata Tjuta (the Olgas), Kata Tjuta Lookout walk, on the Docker River Road, 45 km WNW of Ranger Station, May 1988, *Lazarides & Palmer 63* (AD, DNA). **Queensland.** Cook District: near Telecom Tower, Chillagoe, Mar 1990, *Forster PIF6529* (BRI). Burke District: Hughenden – Mt Isa Road, *c.* 104 km W of Julia Creek, Apr 1975, *Halliday 424* (BRI); Lookout and carpark area, Porcupine Gorge, 65 km N of Hughenden, Apr 1997, *Archer 340* (BRI); 27 km E of Cloncurry; beside the Flinders Highway, Feb 2001, *Wannan 2114 & Jago* (BRI). Mitchell District: Lochern N.P., N of Stonehenge, Mar 1998, *Forster PIF22371 & Booth* (BRI, MEL). Gregory North District: Mayne River crossing on Winton to Jundah Road, Apr 1986, *Neldner 2525 & Stanley* (BRI). **South Australia.** 5 km SW end of Callyamurra Waterhole, Apr 1987, *Reid 685* (AD); minor branch of Red Mulga Creek, May 1987, *Symon 14447* (AD, HO, MEL).

Distribution and habitat: *Euphorbia biconvexa* is endemic to Australia and widespread across the northern part of the continent from Carnarvon, WA, through the northern and southern central areas of the NT and far northern SA to Clermont, in central Qld (**Map 5**). It grows in a wide range of grassland, or eucalypt/*Acacia* woodland communities on sandy to clay soils on plains, rocky hillsides or along drainage lines.

Phenology: Flowers and fruits have been collected throughout the year, particularly from February to September.

Notes: *Euphorbia biconvexa* is similar to *E. coghlanii* and *E. trigonosperma* in habit, general appearance and seed surface texture but differs in having seeds that are lenticulate in transverse section compared with suborbicular for *E. coghlanii* and trigonous for *E. trigonosperma.*

6. Euphorbia bifida Hook. & Arn., *Bot. Beechey Voy.* 213 (1837); *Chamaesyce bifida* (Hook. & Arn.) T.Kuros., *Acta Phytotax. Geobot.* 51(2): 212 (2001 ‘2000’). **Type:** China. “collected about the neighbourhood of Macao and the Islands adjacent”, 20 July – 30 August 1830, *Rev. G.H.Vachell 240* (holo: E-GL *n.v.*; iso: K *n.v.* (cibachrome seen).

Euphorbia vachellii Hook. & Arn., *Bot. Beechey Voy.* 213 (1837); *Chamaesyce vachellii* (Hook. & Arn.) H.Hara, *Enum. Spermat. Jap.* 3: 44 (1954). **Type:** [China.] Macao, 17 July 1830, *G.H.Vachell 241* (holo: E-GL *n.v.* (image seen); iso: K *n.v.*).

Euphorbia micradenia Boiss., in A.DC., *Prodr.* 15(2.2): 27 (1862); *E. macgillivrayi* var. *micradenia* (Boiss.) Domin, *Biblioth. Bot.* 89(4): 311 (1927 ‘1926’); *Chamaesyce micradenia* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. Cook District:] Albany Island, August 1855, *F.Mueller s.n.* (holo: K 186475; iso: G-DC *n.v.* (microfiche IDC 800-73. 2419: II. 4), MEL 530408, P 698542 *n.v.* (image seen).

Euphorbia macgillivrayi Boiss., in A.DC., *Prodr.* 15(2.2): 26 (1862); *E. macgillivrayi* Boiss. var. *macgillivrayi*, Domin, *Biblioth. Bot.* 89(4): 865 (1927 ‘1926’); *Chamaesyce macgillivrayi* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. South Kennedy District:] Port Molle, December 1847, *JMcG* [*J.MacGillivray*] *s.n.* (lecto [here designated]: K 186474).

Euphorbia mitchelliana var. *stenophylla* Benth., *Fl. Austral.* 6: 47 (1873). **Type:** [Northern Territory.] Port Darwin, 7 December 1871, [*M.*] *Schultz 854*; (lecto [here designated]: K 186483).

Euphorbia macgillivrayi var. *yarrabensis* Domin, *Biblioth. Bot.* 89(4): 311 (1927 ‘1926’). **Type:** Queensland. [Cook District:] In xerodrymio apud opp. Yarraba, January 1910, *K.Domin s.n.* (lecto [here designated]: PR 528309).

Euphorbia macgillivrayi var. *pseudoserrulata* Domin, *Biblioth. Bot.* 89(4): 311 (1927 ‘1926’). **Type:** Queensland. [Cook District:] apud opp. Chillagoe, February 1910, *K.Domin s.n.* (lecto [here designated]: PR 528314).

Euphorbia macgillivrayi f. *glabrata* Domin, *Biblioth. Bot.* 89(4): 311 (1927 ‘1926’). **Type:** Queensland. [Moreton District:] prope Brisbane River, 1863–1865, *A.Dietrich 406* (lecto [here designated]: PR 528316).

Euphorbia serrulata Reinw. ex Blume, *Bijdr. Fl. Neerl. Ind.* 635 (1826 ‘1825’), *non* Thuill. **Type:** Timor. *s.d.*, [C.G.C.] *Reinwardt s.n.* (Herb. Lugd. Bat. No. 903.159–328) (holo: L *n.v.* [photo at BRI]).

Illustrations: Brock (1988: 183), as *Euphorbia vachellii*; Wheeler (1992: figs 184P, 185P, 186P (1992), as *E. vachellii.*

Monoecious, annual or herbaceous perennial with short-lived stems produced from thick cylindrical taproot, to 80 cm high, one to few stems arising from rootstock. **Stems** erect to ascending, sparingly branched, smooth, glabrous or densely puberulous on young stems becoming sparser with age; hairs weakly appressed to spreading, crispate, 0.1–0.5 mm long, white. **Interpetiolar stipules** subulate, 0.8–2 mm long, deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 1–3 mm long, smooth, glabrous or with indumentum as for stems; blade linear to oblong, lanceolate to narrow-ovate or narrow-elliptic, 20–80 mm long, 2–12 mm wide, 2.6–20 times longer than wide; adaxial surface green sometimes with reddish tinge on margin, smooth, glabrous or sparsely pubescent with weakly appressed to ascending, crispate hairs 0.3–0.6 mm long; abaxial surface pale green, smooth, glabrous or with indumentum as for adaxial surface; base mostly asymmetric with one side cordate or obtuse, the other cuneate to rounded or slightly cordate; margin serrate sometimes only distally (rarely entire); apex acute to obtuse. **Cyathia** grouped together in congested 2–7 branched dichasial cymes together with a solitary cyathium at the distal nodes; peduncles 3–15 mm long; bracts subulate to narrowly triangular or leaf-like but much smaller than the primary stem leaves; cyathial peduncles 1–4(6) mm long. **Involucres** turbinate, 0.7–1.4 mm long, 1–1.3 mm across; lobes 5, triangular, 0.4–0.7 mm long, margin entire or laciniate; glands 4, stipitate, patelliform or cupuliform, planar or with distinct central pit, transverse-oblong to transverse-elliptic or orbicular in outline, 0.1–0.3 mm long, 0.2–0.4 mm wide, red or yellowish green; gland appendages conspicuous (rarely inconspicuous), spreading radially, broad-obovate to obdeltoid or oblong, 0.3–2.2 mm long, 0.3–2 mm wide, white, glabrous, margin entire; bracteoles 0.8–1.7 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into few to numerous subulate glabrous or hirsute segments. **Staminate flowers** 3–30 per cyathium; pedicels 1.2–1.6 mm long; staminal filaments 0.2–0.3 mm long. **Pistillate flowers**: styles 0.3–0.8 mm long, sometimes connate at the base into a column for *c.* 1/7 of their length, spreading, smooth, glabrous, each bifid for 1/3–2/3 of their length, the apices stout terete. **Capsules** exserted from involucre on pedicel to 3 mm long, very broad-ovate or broad-elliptic in lateral view, 1.7–2.1 mm long, 1.9–2.5 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous or with a sparse indumentum consisting of ± appressed hairs 0.2–0.3 mm long; hypogynous disc entire. **Seeds** broad-ovate in outline, 1.1–1.5 mm long, 0.8–1.1 mm tangentially, 0.8–1 mm radially, tetragonous or trigonal in cross section; dorsal and ventral faces convex, with 3–6 distinct narrow rounded transverse ridges; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta red brown to dark brown. *n* = 8. **Fig. 25E.**

***Additional selected specimens examined*:** **Western Australia.** 'Duncan's Swamp', WSW of Amax Campsite, Mitchell Plateau, May 1978, *Kenneally 6775* (PERTH); 'Rocky Creek', 27.3 km NW of Doongan Station on Gibb River – Kalumburu Road, Jun1987, *Edinger 291* (PERTH); adjacent to Rocky Creek, 27.3 km NW of Doongan Station, Jun 1987, *Koch 544* (PERTH); Calder River crossing, 80 km NNW of Beverley Springs, Jan 1993, *Barrett MDB139* (PERTH). **Northern Territory.** Finniss River Station, Aug 1997, *Cowie 7644 & Mangion* (DNA); East Alligator floodplain, Jun 1992, *Cowie 3031* (DNA); mouth of Daly River, near Palmerston Island, Feb 1994, *Leach 4006* (DNA); 41 miles [*c.* 66 km] E [of] Pine Creek, Apr 1962, *Nelson 301* (AD, BRI, DNA, MEL); Kakadu N.P., Gwalmek, Jan 1995, *Russell-Smith 9182* (DNA); South Bay, Bickerton Island, Jun 1948, *Specht 533* (AD, BRI, MEL); west side of Cape Shield, May 1993, *Cowie 4069 & Leach* (DNA); Maria Island, Jul 1972, *Dunlop 2837* (DNA). **Queensland.** COOK DISTRICT: 1 km E of junction of Piccaninny and Scrubby Creek, Archer Bend N.P., Jun 1993, *Neldner 4102* (BRI). NORTH KENNEDY DISTRICT: 4.8 km S of Inkerman, Bruce Highway, Sep 1976, *Williams 76079* (BRI); 6 km N of Elliot River, 67 km SE of Home Hill, Apr 1975, *McDonald 1371 & Batianoff* (BRI); Nelly Bay, near Dingo Beach, north of Proserpine, Apr 2002, *Bean 18676* (BRI). SOUTH KENNEDY DISTRICT: Hay Point, Nov 1978, *Stanley 78304* (BRI). LEICHHARDT DISTRICT: Sutton Development Road, 'Wedelia', *c.* 1 km W of Kemmis Creek turnoff, Feb 1994, *Champion 1019 & Dixon* (BRI). BURNETT DISTRICT: Branch Creek road, 9.5 km NNW of Binjour, Feb 2005, *Bean 23475* (BRI). MORETON DISTRICT: Opossum Creek, Springfield, Ipswich, Jan 1996, *Bird s.n.* (BRI [AQ487777]). **New South Wales.** Roseberry, Apr 1947, *Jones 4* (BRI [AQ202910]).

***Distribution and habitat*:** *Euphorbia bifida* occurs from South East Asia to Australia. In Australia it is widespread across coastal and subcoastal parts of northern Australia from Derby, WA, to Cairns, Qld and south along the east coast to Rosebery (near Kyogle) in northern NSW (**Map 6**). It grows in a wide variety of habitats; grassland, Melaleuca/eucalypt woodland or open forest communities; on rocky seashores, coastal dunes, swamps, alluvial plains or rocky hillsides. The soils vary from sands to cracking clays.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Typification*:** Boissier (1862) cited two collections in his protologue of *E. macgillivrayi* namely "Ad Port Molle Australiae (M'Gillivray!), Gould Island (Id. forma major!) … (v.s. in herb. Kew!)". Two collections, which are considered as syntypes of the name *E. macgillivrayi*, have been located amongst material of *Euphorbia* on loan to BRI from K [**a:** Voyage of Rattlesnake, Bot. 192, Port Molle, Dec ?3?/47, JMcG. (K) [K 186474]; **b:** Voyage of Rattlesnake, Bot 258, Gould Island, May 22nd 1848, John MacGillivray [K 186473]]. The collection from Port Molle [K 186474] is here selected as lectotype because it is part of the original material, is the more ample and better preserved and has morphology that matches the description in the protologue of this species. Both syntypes are referable to *E. bifida* as applied here.

Bentham (1873) cited four collections made by M.Schultz from Port Darwin in his protologue of *E. mitchelliana* var. *stenophylla* namely "Port Darwin, Schultz, n. 38, 505, 549 and 854". The four collections **a:** Port Darwin, North Australia, *s.d.*, [*Schultz*] *38*, from R. Schomburgk Oct 1869 (K 186481); **b:** Port Darwin, N. Australia, 3/70, *F. Schultz 549* comm. R. Schomburgk (K 186482); **c:** Port Darwin, 7/12/71, *Schultz 854* (K 186483); **d:** Port Darwin, N. Australia, 3 1870, *Schultz 505* comm. R. Schomburgk (K186484), have been located amongst material of *Euphorbia* on loan to BRI from K. B.G. Thomson annotated the collection *Schultz 854* (K 186483) as lectotype in 1989. However, his choice has not been published. We agree with his choice and the collection *Schultz 854* (K 186483) is here selected as lectotype because it is part of the original material, is the more ample and complete of the four collections and has morphology that best matches the description in the protologue of this variety. The syntypes *Schultz 38* and *549* are referable to *E. bifida*, while *Schultz 505* is referable to *E. mitchelliana* var. *mitchelliana* as applied here.

Domin (1827) cited four of his collections from northern Queensland in his protologue of *E. macgillivrayi* var. *pseudoserrulata* namely "Queensland: bei Chillagoe sehr typisch (DOMIN II. 1910); Savannenwälder bei Pentland (DOMIN III. 1910); …Picnic Hill in der Nähe der Russell-Mündung (DOMIN I. 1910); …Beech Mts. (DOMIN III. 1910)". Five sheets [PR 528311, 528312, 528313, 528314, 528315] which are considered as syntypes of the name *E. macgillivrayi* var. *pseudoserrulata*, have been located amongst material of *Euphorbia* on loan to BRI from PR. The collection from Chillagoe [PR 528314] is here selected as lectotype because it is part of the original material, is the more ample and, as Domin comments in the protologue, this collection is very typical of this variety. In 1989, B.G.Thomson annotated the collection from Pentland, *Domin* [PR 528312] as lectotype but this was not published. All of the syntypes [PR 528311, 528312, 528313, 528314, 528315] are referable to *E. bifida* as applied here.

Domin (1827) in his protologue of *E. macgillivrayi* var. *yarrabensis* states "Nordost-Queensland: Savannenwälder in der Ebene bei Yarraba (DOMIN I. 1910)". Three collections (PR 528308, 528309, 528310) which are considered by us as syntypes of the name *E. macgillivrayi* var. *yarrabensis*, have been located amongst material of *Euphorbia* on loan to BRI from PR. The collection (PR 528309) is here selected as lectotype because it is part of the original material, is the more ample and complete of the three collections and has morphology that best matches the description in the protologue of this variety. In 1989, B.G.Thomson annotated the collection *Domin* [PR 528310] as lectotype but this was not published. All of the syntypes [PR 528308, 528309, 528310] are referable to *E. bifida* as applied here.

Domin (1927) cited two collections in his protologue of *E. macgillivrayi* forma *glabrata* namely "sind z. B. die von A. Dietrch sub no. 406 und 1031". Two collections, which are considered as syntypes of the name *E. macgillivrayi* forma *glabrata*, have been located amongst material of *Euphorbia* on loan to BRI from PR [**a:** Queensland. "prope Brisbane River, 1863-1865, A. Dietrich 406" (PR 528316); **b:** Queensland. "prope Brisbane River, 1863-1865, A. Dietrich 1031" (PR

528317). The collection *Dietrich 406* (PR 528316) is here selected as lectotype because it is part of the original material, the more ample and better preserved of the syntypes of this forma. Both syntypes are referable to *E. bifida* as applied here.

Notes**:** *Euphorbia bifida* is similar to *E. mitchelliana* in seed shape and seed surface ornamentation but differs from that in having its cyathia grouped together in congested 2–7 branched dichasial cymes together with a solitary cyathium at the distal nodes.

As circumscribed here, *Euphorbia bifida* is morphologically variable. There is considerable variation in the general habit, indumentum, and leaf dimensions and shape. Although the extreme forms within this species differ considerably from each other, much of the morphological variation appears to intergrade, making it difficulty in assigning some material to one or other form. For this reason we have not formally recognised these variants. A more detailed analysis of Australian populations might lead to the recognition of infraspecific taxa, but a study of the species across its entire range would be desirable to place this variation in context. The more notable variants observed in Australia are:

Annual form: fibrous rootstock, stems erect and little branched, leaves linear to lanceolate 5–23 times as along as wide, margins conspicuously serrate. (e.g. *Leach 4006*, *Kenneally 6775*, *Cowie 1235*). This is widespread and the most commonly collected form and is recorded from Kimberley, WA across the NT to Qld.

Perennial form: perennial rootstock with erect annual stems, leaves narrow-ovate to narrow-oblong, 3–8 times as long as wide, margins not conspicuously serrate (*Dunlop 5593*, *Nelson 301*, *Short 5025*). This occurs in the NT and Qld.

Coastal form often on frontal dunes: perennial rootstock, stems mostly prostrate, leaves narrow-oblong to oblong or narrow-elliptic to elliptic 18–25 mm long, 2–3 times as long as wide. (e.g. *Bean 18676*, *McDonald 1371 & Batianoff*, *Stanley 78304*). It is commonly recorded along the east coast from Cape York south to Fraser Island. The following names placed in synonymy are applicable to this variant: *E. macgillivrayi* and *E. micradenia*.

7. Euphorbia careyi F.Muell., *Fragm*. 11: 64 (1881). **Type:** Western Australia. Fortescue River, in 1878, *H.S.Carey s.n.* (holo: MEL 61116).

Euphorbia bouleyi S.Moore, *J. Linn. Soc., Bot.* 45: 212 (1920). **Type:** [Western Australia.] NW Coast, *s.d.*, *de Bouley s.n.* (holo: BM 812174).

Dioecious (rarely monoecious), herbaceous perennial, 15–80 cm high, often with compact fan-like habit, single or few stems arising from roostock. **Stems** ascending or erect (rarely prostrate, *Royce 7141*, *7077* [PERTH]), much branched, smooth, with a sparse to moderately dense indumentum; hairs appressed to ascending, curved to crispate or sometimes straight, to 0.1 (0.2) mm long, white. **Interpetiolar stipules** narrow-triangular, 0.2–0.5 mm long, deeply bipartite, pubescent; margin laciniate. **Leaves**: petiole 0.2–0.6 mm long, smooth, with indumentum as for stems; blade oblong, obovate or oblong-elliptic, 2–9 mm long, 1.5–5 mm wide, 1.2–1.8 times longer than wide; adaxial surface yellow-green or light to dark green, smooth, with a sparse to moderately dense indumentum (rarely glabrous, *Harris WKH2224* [BRI]); hairs spreading, curved to crispate, to 0.1 mm long; abaxial surface paler than adaxial surface, smooth, with indumentum as for adaxial surface; base asymmetric with one side rounded to cordate, the other cuneate; margin serrulate to serrate or entire; apex rounded to obtuse. **Cyathia** solitary at the upper nodes; peduncles 0.4–1 mm long. **Involucres** turbinate to cupuliform, 0.5–1.1 mm long, 0.8–1.3 mm across; lobes 5, oblong or triangular, 0.4–0.5 mm long, margin laciniate; glands 4, subsessile, patelliform, planar or shallowly concave, transverse-oblong to transverse-elliptic in outline, 0.3–0.5 mm long, 0.4–0.8 mm wide, yellow; appendages conspicuous to inconspicuous or absent, spreading radially; transverse-oblong, 0.2–0.3 mm long, 0.5–0.9 mm wide, yellow (rarely red), glabrous, margin dentate or shallowly lobed; bracteoles 0.5–1.3 mm long, adnate for 1/2–2/3 of their length to involucre, free portion divided into numerous subulate glabrous or hirsute segments. **Staminate flowers** 6–25 per cyathium; pedicels 1–1.4 mm long; staminal filaments 0.3–0.4 mm long. **Pistillate flowers**: styles 0.5–0.8 mm long, connate at the base into a column for 1/5–1/7 of their length, spreading with recurved apices, smooth, glabrous or with a few minute erect hairs proximally, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, broad-elliptic or broad to very broad-ovate in lateral view, 1.4–1.6 mm long, 1.6–1.9 mm across, shallowly 3-lobate with keels acute, papillose, densely hairy; hairs evenly distributed over capsule, spreading or appressed-ascending, to 0.1 mm long; hypogynous disc entire or laciniate. **Seeds** broad-ovate in outline, 0.9–1.2 mm long, 0.7–0.8 mm tangentially, 0.7–0.8 mm radially, tetraquetrous in cross section; dorsal faces ± planar; ventral faces planar or slightly concave; all faces with low faint irregular ridges; exotesta thin, of even thickness, white to pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red brown or pale brown. **Fig. 25F.**

***Additional selected specimens examined*: Western Australia.** Karratha, Jul 1981, *Craig 240* (PERTH); Enderby Island, Jun 1980, *Onus 72* (PERTH); Depuch Island, May 1962, *Royce 7077* (PERTH); floodplain of Robe River, *c.* 8 km SE of Pannawonica, Sep 2003, *Maier & McCreery 511* (BRI); *c.* 50 km S of Dampier on Hamersley Iron Railway line road, Apr 1995, *Mitchell PRP225* (PERTH); *c.* 3 km E of Deepdale Outcamp where the Robe River crosses the Deepdale to Millstream Road, Nov 1996, *Mitchell PRP1492* (BRI); Hamersley Ranges, valley of Bungaroo Creek, 15.4 km SE of Yathala (Old Yalleen) Well, Apr 1995, *Trudgen MET12311 et al.* (PERTH); Tambrey Station, Sep 1969, *Brooker 2122* (PERTH); Tombourah Creek, Marble Bar, Aug 1989, *De Jong s.n.* (PERTH 4026241); Meentheena Conservation Reserve, 6.5 km SSE of Meetheena Station homestead, May 2001, *van Leeuwen 4804* (PERTH); Carawine Gorge, Sep 1991, *Wilson & Rowe 913* (NSW); 2.5 km SW of Silver Grass Peak, 30 km NNE of Mt Farquhar, Jul 1999, *Backhouse BEM22 et al.* (PERTH); 32.2 miles [*c.* 51.8 km] from Roebourne turnoff on Tom Price to Wittenoom Road, Aug 1971, *Ashby 4182* (AD, PERTH); Chichester Range, *c.* 200 km (215 km by road) S of Port Hedland, along the road to the Hamersley Range, Apr 1977, *Eichler 22546* (PERTH); Barlee Range N.R., 3.2 km S of Wongida Well, 12.5 km SW of Mt Florry, 11.6 km E of Minnie Spring, Barlee Range, Aug 1993, *van Leeuwen 1502* (PERTH); Barlee Range, Henry River, Aug 1961, *Royce 6535* (PERTH); 5 km W of Ashburton Downs homestead, Jul 1977, *Mitchell 424* (PERTH); Newman, Jul 1981, *Deighton 110* (PERTH).

***Distribution and habitat*:** *Euphorbia careyi* is confined to the Pilbara, north-western WA, occurring from the Dampier Archipelago, south to Barlee Range and east to Carawine Gorge on the Oakover River (**Map 7**). It grows in hummock grassland, shrubland or low woodland communities on shallow stony, sandy to clay loam soils, on mostly rocky scree slopes or stony hillsides.

***Phenology*:** Flowers and fruits have been collected from February to November (with most collections made from June to September).

***Notes*:** *Euphorbia careyi* can be confused with *E. australis* but is distinguished by its more or less fan-like habit, generally shorter indumentum, larger involucral glands, generally green or yellow-green leaves and dioecy.

The typical form of this species has an indumentum of short, appressed to ascending crispate to curved hairs. A less common variant occurring in the southern half of the species range has an indumentum of short, spreading, ± straight hairs (e.g. *Ashby 4182*, *Deighton 110*).

The following collections are tentatively placed here. Although their general leaf shape, indumentum and involucral glands are consistent with *Euphorbia careyi*, they differ in having shorter styles, darker green leaves with a reddish tinge along margins and coarser toothed leaf margins (Robe River, between Onslow and Roebourne, Aug 1966, *Butler 37* (PERTH); Burrup Peninsula, near Karratha, Aug 2004, *Harris WKH2206* (BRI); on track up Table Top Hill, Karratha, Aug 2004, *Harris WKH2203* (BRI); ‘Grimace Gulch’, through Maraddoo Ridge, Hamersley Range N.P., Sep 1978, *Trudgen 2296* (PERTH); Dolphin Island, Dampier Archipelago, May 2000, *Trudgen 23472* (BRI); ESE of Whim Creek, 7.3 km and 1.3 km S of North West Coastal highway, Jun 2000, *Trudgen 23473* (BRI); Burrup Peninsula, 1.4 km almost due S of Holden Point between Dampier Port and

North West Shelf Gas plant, Jun 2000, *Long MET & A026* (BRI).

8. Euphorbia carissoides F.M.Bailey, *Queensland Agric. J.* 16: 449 (1906); *Chamaesyce carissoides* (F.M.Bailey) P.I.Forst. & R.J.F.Hend., *Novon* 5: 323 (1995). **Type:** Queensland. [Cook District:] Herberton, [March 1906,] *R.C.Ringrose s.n.* (holo: BRI [AQ342536]; iso: K).

Euphorbia schizolepis var. *glabra* Benth., *Fl. Austral.* 6: 47 (1873). **Type:** [Queensland. Cook District:] Gulf of Carpentaria, *s.d.*, *DM* [*F.Mueller*] *s.n.* (holo: K 186491; iso: G-DC *n.v.* [IDC microfiche 800-73. 2416: I. 4], MEL 6122).

***Illustration*:** Forster (1993: 271, fig. 1).

Monoecious, herbaceous woody perennial with few stems arising from woody taproot, 25–120 cm high, the whole plant glabrous. **Stems** ascending to erect; sparingly to much branched, smooth, often with grey-white bloom. **Interpetiolar stipules** subulate, 0.1–2 mm long, entire or deeply bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 1–2.5 mm long, smooth; blade ovate, 5–36 mm long, 3.5–19 mm wide, 1.4–2 times longer than wide; adaxial and abaxial surfaces grey–green or blue green often with red to pink tinge and whitish bloom, smooth; base symmetric, cordate; margin serrate; apex acute or obtuse, sometimes apiculate. **Cyathia** solitary at the nodes; peduncles 1.5–6.5 mm long. **Involucres** turbinate, 2–2.5 mm long, 1.5–2.5 mm across; lobes 5, triangular, 0.5–1 mm long, margin entire; glands 4, shortly stipitate, patelliform, planar or shallowly concave, transverse-oblong to reniform in outline, 0.7–0.8 mm long, 1.3–1.8 mm wide, mostly red; gland appendages conspicuous, spreading radially, transversely oblong, 0.7–1.4 mm long, 2–2.5 mm wide, white turning pink to red with age, glabrous, margin irregularly dentate; bracteoles 2–2.5 mm long, divided into 2–5 ± linear plumose segments. **Staminate flowers** 15–20 per cyathium; pedicels 1.5–2.5 mm long; staminal filaments 0.7–0.8 mm long. **Pistillate flowers**: styles 1.5–2.3 mm long, connate at the base into a column for *c.* 1/3 of their length, erect, spreading distally, smooth, glabrous, entire, the apices terete. **Capsules** exserted from involucre on pedicel to 5 mm long, depressed ovate or transversely broad-elliptic in lateral view, 3.5–4 mm long, 4–5 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate to broad-ovate in outline, 1.9–2.4 mm long, 1.5–1.9 mm tangentially, 1.6–1.9 mm radially, tetragonous in cross-section; dorsal faces planar or slightly convex; ventral faces planar or slightly concave; all faces ± smooth; exotesta of even thickness, *c.* 0.1 mm thick, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta brown or red-brown. **Fig. 25G.**

***Additional selected specimens examined*: Queensland.** Cook District: Bridge Creek Pastoral Holding, Nov 2000, *Stanton 305* (BRI); Blue Hills, Mt Surprise Gemfields, Jul 1987, *Champion 253* (BRI); Blue Hills, 49 km from Mt Surprise township, Mar 1988, *Champion 342* (BRI); O'Briens Creek fossicking area, *c.* 33 km NW (in straight line) of township of Mt Surprise, Sep 2000, *Champion 1673* (BRI); Crystal Creek, Jul 1996, *Ford 1752* (BRI); Pannikin Springs area, 29 km W of Mungana, Jan 1993, *Forster PIF12998 & Bean* (BRI); Pannikin Springs area, Blackdown Station, May 1999, *Forster PIF24369 & Booth* (BRI, MEL); *loc. cit.*, May 2000, *Forster PIF24405 & Booth* (BRI, MEL); Aroonbeta Holding, Walsh River Gorge, near mouth of St Helena Creek, Jan 1989, *Godwin C3159* (BRI); 13.5 km S along Lappa to Mt Garnet Road, Apr 2005, *Forster PIF30791 & McDonald* (BRI); 28.8 km S along Lappa to Mt Garnet Road, Apr 2005, *Forster PIF30805 & McDonald* (BRI); Stannary Hills, Aug 1908, *Bancroft 207* (BRI); Newcastle Range, 24 km E of Georgetown, Aug 1997, *Bean 12235* (BRI, MEL); 40 km N of Georgetown, May 1977, *Rice 2443* (BRI); O'Briens Creek gemfields via Mt Surprise, Jul 1994, *Coveny 16760 et al.* (BRI).

***Distribution and habitat*:** *Euphorbia carissoides* is restricted to north-eastern Qld, occurring from near Georgetown and east to Stannary Hills, with a disjunct occurrence near Hopevale (**Map 8**). It grows on clifflines, rocky outcrops or hillsides in shrubland or eucalypt low open woodland communities on generally shallow soils derived from sandstone, granite or rhyolite substrates.

***Phenology*:** Flowers and fruits have been collected in January, March to May, July to September and November.

***Notes*:** *Euphorbia carissoides* does not appear to have any close relatives in Australia and is easily distinguished from other Australian species of *Euphorbia* by the following combination of characteristics: glabrous, upright woody subshrub; smooth and glabrous capsules; styles entire; seeds tetraquetrous in transverse section with a smooth seed coat.

The species is reported to probably be fire intolerant and only persists in areas not regularly burnt (Forster 1993).

9. Euphorbia centralis B.G.Thomson, *Nuytsia* 8: 353, fig. 2 (1992); *Chamaesyce centralis* (B.G.Thomson) P.I.Forst. & R.J.F.Hend., *Novon* 5: 323 (1995). **Type:** Northern Territory. 3 km SW of Alice Springs, 18 January 1990, *B.G.Thomson 3408* (holo: DNA *n.v.*; iso: AD *n.v.*, BRI, CANB *n.v.*, *fide* Thomson [1992: 353]).

***Illustration*:** Thomson (1992: 355, fig. 2).

Monoecious (rarely dioecious), annual or herbaceous perennial with short-lived stems produced from slender woody taproot, to 30 cm high, few to many stems arising from rootstock. **Stems** erect or occasionally decumbent, much branched, smooth, moderately dense to densely hispidulous, pubescent or pilose; hairs spreading or weakly ascending, straight or crispate, 0.1–1.1 mm long, white. **Interpetiolar** stipules narrow-triangular, 0.2–0.5 mm long, deeply bipartite, indumentum as for stems; margin lacerate. **Leaves**: petiole 0.5–1.3 mm long, smooth, with indumentum as for stems; blade elliptic to broad-elliptic, rotund or obovate, 3–7 mm long, 2–5 mm wide, 1.1–2 times longer than wide; adaxial and abaxial surfaces dark green to grey green (often with reddish tinge especially on margin), smooth, with a sparse to moderately dense indumentum; hairs spreading, ± straight, 0.4–0.6 mm long; base asymmetric, one side rounded to cordate, the other cuneate to obtuse; margin coarsely serrate or sparsely minutely toothed; apex rounded. **Cyathia** solitary at the nodes; peduncles 0.2–1 mm long. **Involucres** turbinate, 0.8–1 mm long, 1–1.1 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin entire or laciniate; glands 4, stipitate, patelliform, shallowly concave, transverse-oblong to transverse-elliptic in outline, 0.1–0.3 mm long, 0.4–0.6 mm wide, cream; gland appendages conspicuous, spreading radially, broad-obovate, 0.4–1.3 mm long, 0.7–1.3 mm wide, pink to red, pale green or cream, glabrous, margin deeply laciniate; bracteoles 0.9–1 mm long, adnate for 1/3 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** 15–20 per cyathium; pedicels *c.* 1.1 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, connate at the base into a column for *c.* 1/10 of their length, ascending, recurved distally, smooth, glabrous, each scarcely bifid or divided *c.* 1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3.5 mm long, elliptic or rarely broad to very broad-ovate in lateral view, 1.5–2 mm long, 1.5–2 mm across, shallowly 3-lobate with keels acute, smooth or minutely papillose, sparsely to densely hairy; hairs mostly evenly distributed over capsule rarely confined to keels, spreading, 0.1–1 mm long; hypogynous disc entire. **Seeds** ovate in outline, 1.3–1.6 mm long, 0.7–0.8 mm tangentially, 0.7–0.9 mm radially, tetraquetrous in cross section; dorsal faces flat to concave; ventral faces concave; all faces with low faint to distinct irregular ridges; exotesta thin, of even thickness, white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown. $n = 11$. **Fig. 25H.**

***Additional selected specimens examined*:** **Western Australia.** Pass of the Abencerrages, Rawlinson Range, Jul 1963, *George 4888* (PERTH); near N base of Mt Aloysius, Jul 1963, *George 5229* (PERTH); near Mt Squires, Barrow Range, Aug 1891, *Helms s.n.* (AD 96832153, MEL 2178635). **Northern Territory.** 66.3 km E of Stuart Highway towards ‘Epenarra’, May 2005, *Bean 23798* (BRI); 22 miles [*c.* 35 km] SSW of Georgina Downs Station, Mar 1953, *Perry 3471* (BRI, DNA); 20 miles [*c.* 32 km] NNE [of] Huckitta homestead, Jul 1970, *Latz 670* (AD, DNA, MEL); 1 km SW Muranji Rockhole, Mt Winter, Oct 1986, *Thomson 1552* (AD, DNA); Chewings Range, N face of range across from Giles Yard Spring, Feb 1990, *Thomson 3434* (DNA); Harts Range, E-end, Plot 1216, May 1988, *Thomson 2413* (DNA, MEL); Penny Springs, Kings Canyon, Jul 1985, *Leach 680* (DNA); 12.5 km N [of] Tempe Downs homestead, Aug 1988, *Barritt 324* (DNA, MEL); Atherrita Bore, 52 miles [*c.* 84 km] SE [of] Todd River homestead, Aug 1964, *Nelson 1303* (AD, BRI, DNA, NSW); Mann Range, 30 miles [*c.* 48 km] NE [of] Mt Davies Camp, Oct 1970, *Latz 908* (AD, DNA); 35 km E [of] Horseshoe Bend homestead, Nov 1993, *Albrecht 5571* (AD, DNA, MEL). **Queensland.** GREGORY NORTH DISTRICT: 21 km

WNW of 'Marion Downs', Sep 1978, *Purdie 1336* (BRI); Glenormiston, Toko Range, *c.* 1.8 km S of S-bend Gorge, Mulligan River on track to Cravens Peak homestead, Jun 2010, *Halford Q9867 & Forster* (BRI). **South Australia.** between Deering Hills and Mann Ranges, *c.* 18 km NE of Mt Cooperinna, Sep 1978, *Barker 3437* (AD, NSW); at foot of Mt Harriet, Sep 1963, *Whibley 947* (AD); 7 km E of Marys Well, De Rose Hill Station, Aug 1992, *Badman 6108* (AD); Beresford Hill, Oct 1978, *Chorney 992* (AD, NSW); 2 km SW of Bulgunnia Station homestead, Nov 1992, *Badman 6572* (AD).

***Distribution and habitat*:** *Euphorbia centralis* occurs in central Australia from Tennant Creek, NT, south to Bulgunnia Station (S of Coober Pedy), SA and from Cavanagh and Barrow Ranges, WA east to Boulia, western Qld with a disjunct occurrence near Quilpie, south-western Qld (**Map 9**). It grows mostly in hummock grassland or *Acacia* shrubland communities on rocky scree slopes or stony hillsides. The soils are sandy, and often shallow and rocky, derived from granite, sandstone or limestone substrates.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from March to October.

***Notes*:** *Euphorbia centralis* is similar to *E. australis* and can be difficult to distinguish from *E. australis* var. *erythrantha* in northern SA where these taxa distributions overlap. Mature plants of *Euphorbia centralis* exhibit a rounded shrub-like habit and have gland appendages 0.4–1.3 mm long that are deeply laciniate (versus 0.1–0.2(0.4) mm long and shallowly to deeply toothed for *E. australis* var. *erythrantha*).

10. Euphorbia cinerea W.Fitzg., *J. & Proc. Roy. Soc. Western Australia* 3: 161 (1918). **Type:** Western Australia. Devil's Pass [Windjana Gorge], Napier Range, May 1905, *W.V.Fitzgerald 591* (holo: PERTH).

Monoecious, herbaceous perennial with many short-lived stems produced from slender taproot, the whole plant glabrous. **Stems** prostrate, sparingly branched, longitudinally ridged. **Interpetiolar stipules** subulate, 0.6–0.8 mm long, deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.2–0.7 mm long, smooth; blade oblong or obovate, 4–8 mm long, 2.6–5 mm wide, 1.6–2 times longer than wide, smooth, pale green; base asymmetric with one side cordate, the other obtuse; margin sparsely minutely toothed distally; apex rounded to retuse. **Cyathia** solitary at nodes, often clustered on short leafy lateral branchlets; peduncles 0.1–0.2 mm long. **Involucres** campanulate or turbinate, 0.8–1 mm long, 0.6–0.8 mm across; lobes 5, triangular, 0.2–0.5 mm long, margin entire or serrulate; glands 4, stipitate, cupuliform, with distinct central pit, transverse-oblong or transverse-elliptic in outline, *c.* 0.1 mm long, 0.2–0.4 mm wide, pink; gland appendages conspicuous, spreading radially, reniform, 0.1–0.3 mm long, 0.4–0.8 mm wide, pink to white, glabrous, margin entire or shallowly lobed; bracteoles 0.6–0.8 mm long, entire or divided into few subulate glabrous segments. **Staminate flowers** 1–5 per cyathium; pedicels 0.9–1.1 mm long; staminal filaments 0.1–0.3 mm long. **Pistillate flowers**: styles 0.3–0.4 mm long, spreading, smooth, glabrous, entire, the apices terete. **Capsules** exserted from involucre on pedicel to 1.5 mm long, broad to very broad-ovate in lateral view, 1.1–1.3 mm long, 1.3–1.5 mm across, shallowly 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 0.7–0.8 mm long, 0.4–0.5 mm tangentially, 0.4–0.5 mm radially, tetraquetrous in cross section; dorsal faces slightly concave; ventral faces concave; all surfaces smooth or with 1 or 2 low faint ridges; exotesta thin, of even thickness, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown or red-brown. **Fig. 25I.**

***Additional selected specimens examined*:** **Western Australia.** upper reaches of Barker River, 2 km N of Mt Hart homestead, Jun 1987, *Edinger 421* (PERTH); Black Stone Mine, Leopold Range, May 1988, *Cranfield 6728* (PERTH); 3 km S of Karriwell Bore; 100 km E of Derby, Jun 1988, *Wilson 12788* (PERTH); Windjana Gorge N.P., Aug 1982, *Conrick 1083* (AD); Camballin Road, 14.7 km S of junction with Derby – Fitzroy Crossing Road, Apr 1985, *Aplin 128 et al.* (PERTH); Windjana Gorge, Napier Range, Jul 1974, *Carr 3865 & Beauglehole ACB47643* (NSW, PERTH); 1 mile [*c.* 1.6 km] from Calwynyardah turnoff, Fitzroy road, Mar 1967, *Power 311* (PERTH); *c.* 6 km SE of Gibb River Road along road to Mt House Station, May 1985, *Aplin 991 et al.* (PERTH); Geikie Gorge N.P., Jul 1974, *Carr 3773 & Beauglehole ACB47551* (NSW, PERTH); Gogo [Station], Apr 1951, *Gardner 10016* (PERTH); E of junction of Kununurra – Wyndham – Halls Creek road, Jul 1974, *Carr 3201 & Beauglehole ACB46979* (NSW, PERTH); Ord River, NNW of Goosehole Yard, Bungle Bungle N.P., Jun 1989, *Menkhorst 933* (DNA). **Northern Territory.** Birrindudu Station, Jun 1994, *Egan 3826* (DNA).

***Distribution and habitat*:** *Euphorbia cinerea* occurs in the southern Kimberley, WA from near Derby and eastward to adjacent parts of the NT (**Map 10**). It grows on red sand to loam soils on plains or floodplains in grassy open shrubland or woodland communities, or in stony red soils on hills in hummock grassland communities.

***Phenology*:** Flowers and fruits have been collected from March to August.

***Notes*:** *Euphorbia cinerea* resembles *E. albrechtii* and *E. petala*. For features distinguishing *E. cinerea* from *E. albrechtii* and *E. petala*, refer to the 'Notes' section under *E. albrechtii*.

This species has been misidentified as *E. drummondii* (e.g. Wheeler *et al.* 1992). It is easily distinguished from *E. drummondii* by its generally smaller habit, capsules and seeds, capsule shape and seed sculpturing.

The collection site on the type sheet (PERTH) is recorded as "Devil's Pass" rather than Wingrah Pass, as recorded in Fitzgerald's protologue for this species. Royce (in Wilson 1974) confirmed that the names refer to the same locality. Devil's Pass is now known as Windjana Gorge.

11. Euphorbia clementii Domin, *Biblioth. Bot.* 89(4): 308–309 (1927 '1926'). **Type:** [Western Australia.] inter Ashburton et DeGrey River, in 1900, *E.Clement s.n.* (holo: PR 528292).

Monoecious, annual (?) to 60 cm high, few to many stems arising from base, the whole plant glabrous. **Stems** ascending to erect (rarely semiprostrate, *Mitchell PRP288* [PERTH]), sparingly to much branched, smooth. **Interpetiolar stipules** subulate, 0.5–1.5 mm long, deeply bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 1–2 mm long, smooth; blade oblong or oblong-obovate, 12–18 mm long, 5–9 mm wide, 2.1–2.3 times longer than wide; adaxial surface green, smooth; abaxial surface pale green, smooth; base symmetric, rounded; margin entire; apex rounded. **Cyathia** solitary at the nodes, mostly on distal portion of stems. **Involucres** cupuliform, 1.5–2 mm long, 1.8–3.5 mm across; lobes 5, oblong or obovate, 1–1.3 mm long, margin deeply laciniate distally; glands 4, sessile, appressed to abaxial surface of involucre, patelliform, planar, transverse-elliptic to orbicular in outline, 0.8–1.1 mm long, 0.7–1.4 mm wide, yellowish green; gland appendages absent; bracteoles 1.3–1.6 mm long, divided into numerous ± linear hirsute segments. **Staminate flowers** 60–75 per cyathium; pedicels 1.5–2 mm long; staminal filaments 0.4–0.8 mm long. **Pistillate flowers**: styles 0.7–1 mm long, ascending, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices clavate. **Capsules** exserted from involucre on pedicel to 6 mm long, broad-elliptic or transversely broad-elliptic in lateral view, 2.7–3 mm long, 3.2–3.5 mm across, deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** oblong or elliptic to broad-elliptic in outline, 1.9–2 mm long, 1.3–1.5 mm tangentially, 1.3–1.5 mm radially, trigonal to suborbicular in cross section; dorsal and ventral faces convex, smooth; exotesta thin, of even thickness, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta red-brown to brown. **Fig. 25J.**

***Additional selected specimens examined*:** **Western Australia.** 20 km E [of] De Grey River crossing on Port Hedland/Broome Road, May 1991, *Thomson 3498* (AD, BRI, NT); HGM site 4, Y9 Crustal Deposit, Yarrie Iron Ore Mine site, *c.* 190 km E of Port Hedland, Apr 1998, *Maier s.n.* (PERTH 5086590); Gorge Creek, on Port Hedland – Marble Bar Road, Apr 2006, *Bean 25126* (BRI); Talga Gap, S of Coongan Siding, Jun 1941, *Burbidge 1053* (PERTH); 15.8 km N of Talga, Sep 1986, *Chinnock 6987* (AD); *c.* 37 km SE of Yandeyarra on southern access track from Great Northern Highway, Apr 1995, *Mitchell PRP288* (PERTH).

***Distribution and habitat*:** *Euphorbia clementii* is confined to the Pilbara, north-western WA, occurring in an area more or less bounded by Port Hedland, Marble Bar and the Mungaroona Range (**Map 11**). It grows in *Triodia* grassland communities, on gravelly clay loam soils on slopes or stony rises or on sandy soils on plains. It is often noted on specimen labels to be growing in areas "recently burnt".

Phenology: Flowers and fruits have been collected from April to June.

Notes: *Euphorbia clementii* is a distinctive species but appears most closely related to *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*. It is easily distinguished from all three species by its large, sessile, disk-like involucral glands that are appressed to the outside of the involucral cup (versus shortly stipitate involucral glands spreading radially from the involucral rim and perpendicular to the outside of the involucral cup for *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*), involucral lobes oblong or obovate, 1–1.3 mm long (versus triangular or subulate and 0.3–1.1 mm long for *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*) and more numerous staminate flowers per cyathia (60–75 per cyathia versus up to 35 per cyathia for *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*).

12. Euphorbia coghlanii F.M.Bailey, *Queensland Dept. Agric. Stock Bot. Bull.* 13: 12 (1896); *Chamaesyce coghlanii* (F.M.Bailey) D.C.Hassall ex P.I.Forst. & R.J.F.Hend., *Novon* 5: 323 (1995). **Type:** Queensland. Gregory North District: Roxborough, Georgina River, December 1895, *F.M.Bailey s.n.* (holo: BRI [AQ342538]); **Epitype** (here chosen): Queensland. Burke District: 20 km (by road) E of Musselbrook Mining Camp on road to Ridgepole Waterhole, 175 km N of Camooweal – Lawn Hill National Park, 27 April 1995, *R.W.Johnson MRS379 & M.B.Thomas* (BRI).

Monoecious, annual or herbaceous perennial with short-lived stems produced from slender woody taproot, to 80 cm high, few to many stems arising from rootstock. **Stems** erect, sparingly to much branched, smooth, glabrous or with a sparse to moderately dense indumentum (pubescent or pilose); hairs ± appressed or spreading, crispate, 0.1–0.4 mm long, white. **Interpetiolar stipules** narrow-triangular or subulate, 0.6–1.5 mm long, entire or bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 0.7–2 mm long, smooth, glabrous or with indumentum as for stems; blade oblong, lanceolate, narrow-ovate to broad-ovate or oblong-elliptic, 14–36 mm long, 2–10 mm wide, 2.2–9 times longer than wide; adaxial surface subglaucous, dull green or pale green (often with reddish tinge), smooth, glabrous; abaxial surface glaucous or pale green, smooth, glabrous or sparsely hairy with appressed-ascending to ascending, ± straight or crispate hairs 0.1–1 mm long; base asymmetric with one side cordate, the other rounded; margin entire or serrulate; apex acute to rounded. **Cyathia** solitary at the upper nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 1–9 mm long. **Involucres** campanulate or turbinate, 0.8–1.2 mm long, 1.1–1.3 mm across; lobes 5, triangular to subulate, 0.4–0.5 mm long, margin entire or laciniate; glands 4, stipitate, patelliform, planar to concave (rarely cupuliform with distinct central pit), transverse-elliptic to ± orbicular in outline, 0.1–0.2 mm long, 0.1–0.6 mm wide, red or yellowish green; gland appendages conspicuous to inconspicuous, spreading radially, very broad-obovate to obdeltoid, 0.1–0.5 mm long, 0.5–0.9 mm wide, red or white, glabrous, margin entire; bracteoles 0.7–0.8 mm long, adnate for *c.* 1/4 of their length to involucre, free portion entire or divided into subulate glabrous segments. **Staminate flowers** 5–25 per cyathium; pedicels 1.1–1.4 mm long; staminal filaments 0.2–0.3 mm long. **Pistillate flowers**: styles 0.6–0.8 mm long, erect to spreading, recurved distally, smooth, glabrous, each bifid for 1/3–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 4 mm long, transversely broad-elliptic in lateral view, 1.8–2 mm long, 1.8–2.4 mm across, deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** oblong to ovate in outline, 1.2–1.4 mm long, 0.8–1 mm tangentially, 0.8–1 mm radially, suborbicular in cross section; dorsal and ventral faces convex, smooth; exotesta thin, of even thickness, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta red-brown to dark brown. *n* = 8. **Fig. 25K.**

Additional selected specimens examined: **Western Australia.** 10 km from Kununurra on road to Ivanhoe Springs, Apr 1985, *Aplin 568 et al.* (PERTH); 15 km S of Victoria Highway, 40 km E of Kununurra along Victoria Highway, Apr 1989, *Halford H51* (BRI);

Barrow Island, Oct 1980, *Buckley 6901* (PERTH); 2.4 km WSW of Coondewanna Hill, Hamersley Ranges, Jun 1997, *Trudgen 16673* (PERTH); *c.* 1 km S of Newman on Great Northern Highway, Mar 1994, *Mitchell PRP120* (PERTH); 1 km SSW of Erallinga Pool, Hamersley Ranges, Apr 1997, *Trudgen 15267* (PERTH); 4.75 km ESE of West Angela Hill, Hamersley Ranges, Jun 1997, *Trudgen 16729* (PERTH). **Northern Territory.** 2 km NW of Timber Creek, Dec 1994, *Barritt 1625* (DNA, MEL); Longreach Waterhole, Elliott, Feb 1988, *Thomson 2187* (AD, BRI); Muckaty, near homestead, Mar 1955, *Chippendale 1071* (BRI, DNA); Brunette Downs Station on stockroute to racecourse, Aug 1986, *Henshall 4127* (AD, DNA); 5 miles [*c.* 8 km] W of Frewena Roadhouse, Jul 1971, *Henry 194* (BRI); Soudan Station, No. 103 Bore, Nov 1986, *Henshall 4132* (DNA). **Queensland.** Burke District: Beames Brook on Burketown to Camooweal Road, May 2000, *Jago 5699 & Wannan* (BRI); 67 km WNW of Mt Isa, 6 km N of Mingera Creek, Apr 1989, *Harris 335* (BRI); Roxmere Station, S of Cloncurry, Apr 2003, *Booth 3179 & Kelman* (BRI); 2 km by road from Hughenden towards Winton, Apr 2006, *Halford Q9015 & Batianoff* (BRI). Mitchell District: 30 miles [*c.* 48 km] W of Blackall, May 1975, *Hassall 7530* (BRI). Gregory North District: Bladensburg N.P., S of Winton and 2 km NE of Bladensburg homestead, Mar 1998, *Forster PIF22278 & Booth* (BRI, MEL). Leichhardt District: 15 km SE of Capella, Mar 1995, *Fensham 2572* (BRI); 16 miles [*c.* 26 km] NW of Rolleston, May 1975, *Hassall 7536* (BRI).

Distribution and habitat**:** *Euphorbia coghlanii* occurs across northern Australia from the Pilbara and Kimberley, WA, extending through the northern central region of the NT, and eastward to central Qld (**Map 12**). It grows in grassland or open woodland communities, on mostly dark cracking clay soils rarely on sands, on plains, alluvial flats or along drainage lines. It has been rarely recorded in white coastal sands (*Buckley 6901* [PERTH]).

Phenology**:** Flowers and fruits have been collected throughout the year, particularly from January to August.

Notes**:** *Euphorbia coghlanii* is similar to *E. biconvexa* and *E. trigonosperma* but differs in having seeds that are suborbicular in transverse section versus lenticulate for *E. biconvexa* and trigonous for *E. trigonosperma*. It also differs from *E. trigonosperma* in habitat preference as well. *Euphorbia coghlanii* inhabits mostly dark cracking clay soils on plains, alluvial flats compared to sandy soils on coastal or inland dunes, in well-drained sandy soils on stony slopes of sandstone and limestone hills, and in sandy alluvium along drainage lines.

The holotype of Bailey's *Euphorbia coghlanii* is in poor condition. It currently consists of a few almost leafless stems as well as a fragment packet containing a few fragmented leaves and stems, and a single cyathium. The Bailey collection (BRI [AQ342538]) as well as the illustration with the protologue of *E. coghlanii* lack sufficient details to fix the application of the name. As there is no other original material available to clarify the application of *E. coghlanii*, an epitype is here nominated. The collection *Johnson MRS379 & M.B. Thomas* (BRI [AQ 587084]) is chosen here as epitype. This collection has morphology that is similar to the remaining fragments of the original material and matches the description in the protologue.

13. Euphorbia crassimarginata Halford & W.K.Harris, **species nova** similis generatim *E. drummondii* Boiss. sed ab ea glandulis plerumque majoribus (0.2–0.3 × 0.4–0.5 mm) ore manifestioribus incrassatis appendicem petaloidam carens (ad vicem 0.15–0.2 × 0.2–0.4 mm glandulae appendicibus transverso-linearis usque 1 mm longis) stylis 0.4–0.5 longis bifidis apicibus teretibus (ad vicem 0.2–0.3 mm longis integris vel vix bifidis) differt. **Typus:** Queensland. Burke District: 31 km by road from junction of Burke and Gulf Development Roads towards Flinders River, 16 January 2005, *K.R.McDonald KRM3414* (holo: BRI, iso: DNA, *distribuendi*).

Monoecious, annual to 40 cm high, with few stems arising from fibrous rootstock, the whole plant glabrous. **Stems** erect (rarely prostrate, *Pullen 8875* [BRI]), sparingly branched, longitudinally ridged. **Interpetiolar stipules** narrow-triangular, 0.7–1 mm long, deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.5–0.8 mm long, smooth; blade narrow-oblong or narrow-ovate, sometimes falcate, 7.5–17 mm long, 1.7–3.4 mm wide, 3.6–5.9 times longer than wide; adaxial and abaxial surfaces green to pale green often with reddish tinge especially along margins, smooth or minutely papillose; base asymmetric with one side obtuse, the other rounded; margin sparsely minutely toothed distally; apex obtuse or acute. **Cyathia** solitary at nodes, often clustered on short leafy lateral branchlets; peduncles 0.4–1 mm long. **Involucres** turbinate, 0.7–0.8 mm long, 0.8–0.9 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin fimbriate; glands 4, stipitate, cupuliform, with distinct central pit and thicken rim, transverse-elliptic or orbicular in outline, 0.2–0.3 mm long, 0.4–0.5 mm wide, red to purple; gland appendages absent; bracteoles subulate, 0.5–0.6 mm long, adnate for *c.* 1/3 of their length to involucre, glabrous. **Staminate flowers** 5 per cyathium; pedicels 0.7–0.8 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.5 mm long, spreading, smooth, glabrous, each bifid for 1/3–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 1.8 mm long, broad-elliptic in lateral view, 1.7–1.9 mm long, 1.6–1.8 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** oblong-ovate in outline, 1.2–1.5 mm long, 0.7–0.8 mm tangentially, 0.7–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces concave; all faces with 3–6 faint to distinct transverse ridges; exotesta of uneven thickness, distinctly thicker on transverse ridges, white to pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown. *n* = 11. **Figs 3, 25L.**

***Additional selected specimens examined*: Northern Territory.** 27 km SW [of] Daly Waters, Feb 1989, *Thomson 3147* (DNA); 22 km N [of] Ucharonidge homestead, Feb 1989, *Thomson 3246* (AD); Tanumbirini Station, Carpentaria Highway, Feb 1988, *Thomson 2203* (DNA). **Queensland.** Burke District: *c.* 20 miles [*c.* 32 km] W of Burketown, Jul 1974, *Hassall 7472* (BRI); *c.* 15 km SW of Normanton, along the road to Mogoura Station, Apr 1974, *Pullen 8875* (BRI); 28.4 km by road towards Flinders River from junction of Burke and Gulf Development Roads, Jan 2005, *McDonald KRM3449* (BRI); 5 km S of Normanton, May 1976, *Hassall 7633* (BRI); 15 km S of Normanton on Cloncurry road, 200 m W of highway, Apr 2004, *Thompson BUR157 & Newton* (BRI); near Eight Mile Creek, *c.* 40 km NNE of Normanton, on track *c.* 2.5 km off Burke Developmental Road, Jun 2001, *Turpin GPT873 & Thompson* (BRI); *c.* 70 miles [*c.* 113 km] S of Burketown, Jul 1974, *Hassall s.n.* (BRI [AQ475167]); 17.5 km N of Donors Hill turnoff, on Cloncurry – Normanton Road, May 1976, *Farrell TF414* (BRI); Bang Bang Jumpup on Cloncurry – Normanton Road, 105 km S of Normanton, Mar 1977, *Farrell TF793* (BRI); 90 km NNW of Mt Isa on remote station track, May 2006, *Booth CAM08-10 & Kelman* (BRI); 54.7 km by road S of Flinders River road bridge, Mar 2005, *McDonald KRM4047* (BRI); 125.7 km by road S of Flinders River road bridge, Mar 2005, *McDonald KRM4059* (BRI). Mitchell District: Ventcher Station, 82 km SW of Torrens Creek, Apr 2005, *Thompson TAN208 & Booth* (BRI); 83 km SSE of Torrens Creek on Jednock Station, Apr 2005, *Thompson TAN236 & Booth* (BRI).

***Distribution and habitat*:** *Euphorbia crassimarginata* extends from Daly Waters, NT, eastward to near Hughenden, Qld (**Map 13**). It grows in eucalypt or *Melaleuca* open woodland, or *Acacia* woodland communities, on plains or low lateritic hills, and in Mitchell grassland on plains. The soils are variable in texture: sand, clay loam to cracking clays.

***Phenology*:** Flowers and fruits have been collected from January to July.

***Notes*:** *Euphorbia crassimarginata* bears a general resemblance to *E. drummondii* but differs from it by having generally larger glands (0.2–0.3 × 0.4–0.5 mm) with more pronounced thickened rim and lacking a petaloid appendage (versus 0.15–0.2 × 0.2–0.4 mm, gland appendages present, transverse-linear, to 0.1 mm long for *E. drummondii*), and styles 0.4–0.5 mm long, each bifid for 1/3–2/3 of their length, the apices terete (versus 0.2–0.3 mm long, each entire or scarcely bifid, the apices clavate for *E. drummondii*).

***Etymology*:** The specific epithet is from Latin *crassus*, thick, and *–marginatus*, margined, in reference to the thickened margin of the involucral glands of the species.

14. Euphorbia dallachyana Baill., *Adansonia* 6: 285–286 (30 July 1866); *Chamaesyce dallachyana* (Baill.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** Queensland. [Port Curtis District:] Rockhampton, *s.d.*, [*J.Dallachy s.n.*] (holo: P 313101; iso: MEL 68199).

Euphorbia minutifolia Boiss., in A.DC., *Prodr.* 15(2): 1263 (late August 1866). **Type:** [Queensland. Cook District:] Gulf of Carpentaria, *s.d.*, [*W.Landsborough s.n.*] (holo: G-DC *n.v.* [microfiche IDC 800-73. 2421: II. 8]; iso: MEL 68205, 68204).

***Illustration*:** Auld & Medd (1987: 160).

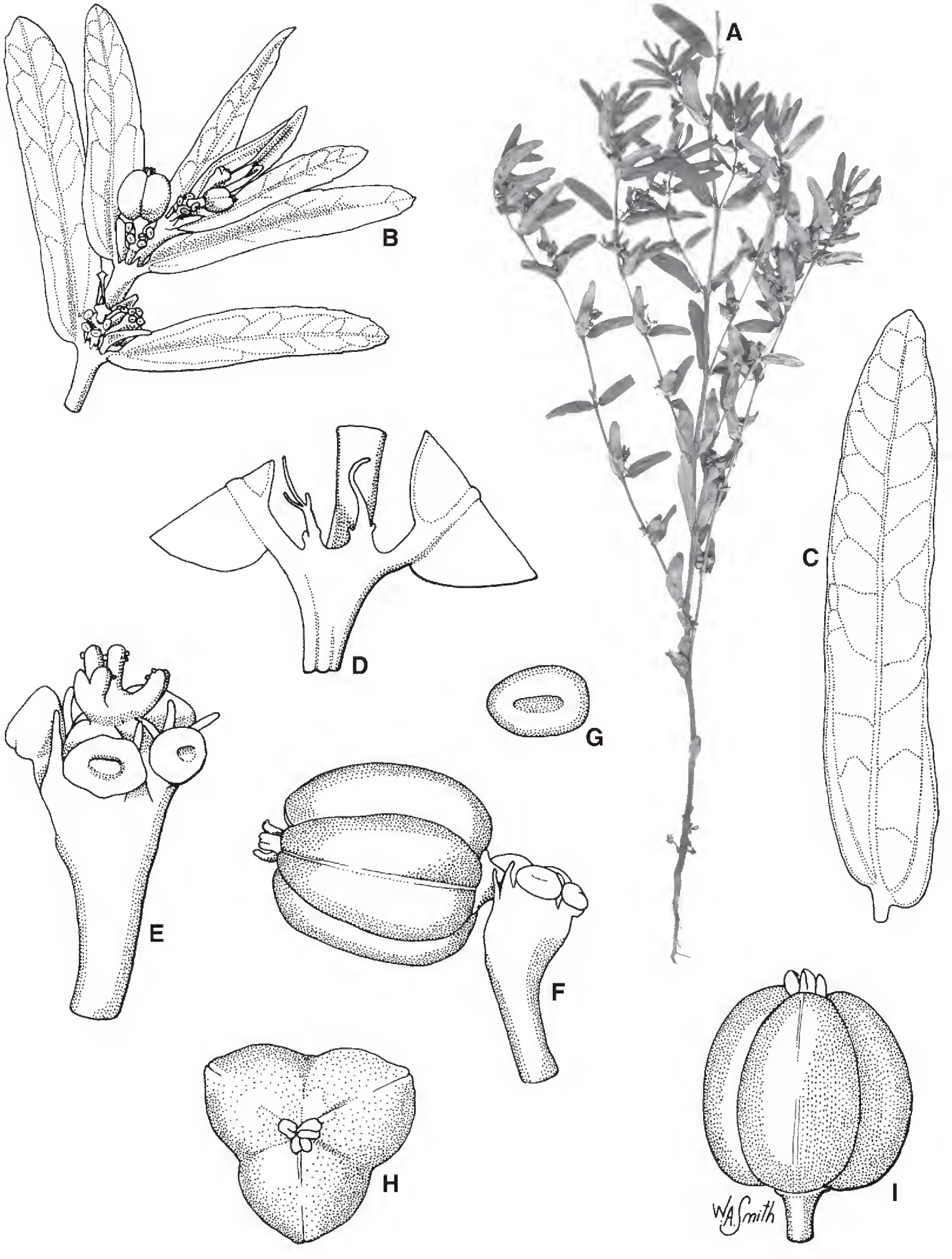

Fig. 3. ***Euphorbia crassimarginata.*** A. habit ×0.6. B. branchlet with cyathia ×4. C. leaf ×4. D. stipules ×12. E. cyathia with female flower ×32. F. capsule with cyathia ×16. G. cyathial gland, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A from *McDonald KRM3414* (BRI); B–I from *McDonald KRM3449* (BRI). Del. W.Smith.

Monoecious, annual or herbaceous perennial with short-lived stems produced from slender woody taproot, to 5(20) cm high, many stems arising from rootstock, the whole plant glabrous. Stems prostrate (rarely ascending to erect), much branched, smooth. **Interpetiolar stipules** triangular to broad-triangular, 0.2–1.1 mm long, entire or bipartite, glabrous; margin lacerate. **Leaves**: petiole 0.5–1.5 mm long, smooth; blade oblong, ovate, obovate to broad-obovate, elliptic to broad-elliptic or subrotund, 2–9 mm long, 1.3–7 mm wide, 1–2 times longer than wide; adaxial and abaxial surfaces green or blue-green (sometimes tinged red especially along margins), smooth (rarely minutely papillose); base asymmetric with one side rounded to cordate, the other obtuse to rounded; margin entire or minutely toothed distally; apex obtuse, mucronate or retuse. **Cyathia** solitary at the nodes; peduncles 0.5–5 mm long, smooth. **Involucres** turbinate, 0.6–0.9 mm long, 0.5–1 mm across; lobes 5, triangular to subulate, 0.2–0.4 mm long, margin fimbriate; glands 4, stipitate, cupuliform, with a shallow central pit, transverse-oblong, or transverse-elliptic in outline, 0.1–0.2 mm long, 0.2–0.4 mm wide, pink or pale green; gland appendages conspicuous to inconspicuous, spreading radially, transverse-linear, 0.05–0.3 mm long, 0.2–0.6 mm wide, pink or white, glabrous, margin entire or shallowly lobed; bracteoles 0.5–0.8 mm long, adnate for 1/3 of their length to involucre, free portion divided into few to numerous subulate glabrous or hirsute segments. **Staminate flowers** 5–10 per cyathium; pedicels 0.6–1 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.1–0.4 mm long, spreading to erect, smooth, glabrous, bifid for up to 1/2 of their length, the apices clavate or terete. **Capsules** exserted from involucre on pedicel to 2.2 mm long, transversely broad-elliptic in lateral view, 1.5–2.2 mm long, 1.5–2.4 mm across, shallowly 3-lobate with keels obtuse, smooth; hypogynous disc laciniate or entire. **Seeds** ovate or broad-ovate in outline, 1.1–1.5 mm long, 0.8–0.95 tangentially, 0.7–0.9 mm radially, tetraquetrous or tetragonous in cross section; dorsal and ventral faces planar to convex, with 2–4 faint transverse ridges; exotesta thin, of even thickness, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta brown or red-brown. *n* = 11, 22. **Fig. 25M.**

***Additional selected specimens examined*: Western Australia.** Fitzroy River, Great Northern Highway, Broome – Derby Road, Jul 1974, *Carr 4305 & Beauglehole 48083* (NSW; PERTH); corner of Kargotich & Mundijong Roads, Mundijong, May 2009, *Hislop 3880* (BRI, MICH). **Northern Territory.** Dashwood Crossing, Jul 1995, *Booth 1031* (DNA); Kalkaringi, Mar 1990, *Thomson 3492* (DNA); Lake Nash Station, Beantree Bore, Jul 2000, *Risler 472* (DNA); between Top Springs & Timber Creek, Jul 1974, *Carr 2739 & Beauglehole 46518* (MEL, NSW). **Queensland.** BURKE DISTRICT: Gregory River crossing, Riversleigh Station, May 1990, *Latz 11639* (DNA). SOUTH KENNEDY DISCTRICT: 5 km from Moray Downs homestead on Clermont Road, May 1995, *Forster PIF16701 & Figg* (BRI). PORT CURTIS DISTRICT: Glen Geddes, *c.* 45 km NNW of Rockhampton, Nov 2003, *Halford Q8076 & Forster* (BRI, MEL, NSW). MORETON DISTRICT: Blenheim, W of Laidley, Dec 2004, *Forster PIF30528* (BRI); White Swamp Road, S of Boonah, Mar 2004, *Bean 21752* (BRI). **South Australia.** *c.* 6 km S of Blanchetown, Feb 1973, *Weber 3521* (AD); *c.* 1 km NW of Big Bend S of Swan Reach, Apr 1973, *Donner 4123* (AD); Adelaide Botanic Gardens, Car Park, Jan 1992, *Smith 2958* (AD). **New South Wales.** 0.4 km S of Gurley Creek, on Moree – Narrabri Road, Jan 1996, *Bean 9509* (BRI, MEL, NSW); alongside Ironbark Creek, W of Woodsreef Mine, Mar 1994, *Hosking 958* (MEL, NSW); Buchanan Lamington Colliery, 4.8 km from Warkworth, Jun 1975, *Coveny 6554 & Powell* (NSW); 10 km W of Balranald, Dec 1987, *Thomson 2300* (NSW [mixed collection with *E. serpens*], NT); 20.9 km SE along Aratula Road towards Tocumwal off the Deniliquin – Finley Road, Apr 1988, *Coveny 12903 et al.* (MEL, NSW). **Victoria.** 1.5 km NE [of] Colignan, Apr 1983, *Forbes 1416* (MEL); Johnson's Bend, Murray River near Mildura, May 1969, *Craven 1575* (MEL); Yarrawonga, Jan 1982, *Aston 2180* (MEL).

***Distribution and habitat*:** *Euphorbia dallachyana* is widespread in eastern Australia with scattered localities in northern and south-western WA, and north-western NT (**Map 14**). It grows in grassland, eucalypt woodland/open forest communities on plains, alluvial flats or river and creek banks, rarely on rocky hillsides. The soils vary from sand to cracking clays. It is often recorded in disturbed areas such as roadsides, in urban parklands, along railways, pastures and cultivated land.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from November to May.

Notes: *Euphorbia dallachyana* is characterised by the lack of an indumentum; stems not longitudinally ridged; stipules triangular to broad-triangular; glands cupuliform with a shallow central pit; gland appendages always present although small (to 0.3 mm long) and transverse-linear with margin entire or shallowly lobed; seed surfaces with 2–4 faint transverse ridges; capsules transversely broad-elliptic in lateral view.

Bentham (1873) placed *Euphorbia dallachyana* in synonymy under *E. drummodii*. Hassall (1976) reinstated it to specific rank (as *Chamaesyce dallachyana*). *Euphorbia dallachyana* is similar to *E. drummondii* in its involucral glands, gland appendages, and capsule shape and size. It differs from that species in its leaf form and stipule form, and seed surface sculpturing.

Euphorbia dallachyana as circumscribed here is variable in style and hypogynous disc morphology. The typical variant occurs widely throughout the species distributional range although it is more common in the northern part of the range. It has styles bifid for *c.* 1/2 of their length with the apices ± terete and the hypogynous disc with a laciniate fringe. The hypogynous fringe is not always present at the base of all capsules on the one plant and can vary from just a few slender subulate lobes to a much divided broad lobe (e.g. *Hislop 3880*, *Hosking 958*, *Smith 2958*, *Halford Q8076 & Forster*). Hassall (1977) records this typical variant as a tetraploid with a base chromosome number $n = 22$.

A second variant occurring in the southern part of the species range (through NSW, SA, Vic and WA) has styles that are bifid for up to 1/3 of their length with ± erect, stout clavate apices and the hypogynous disc undivided (e.g. *Donner 4123*, *Craven 1575*, *Coveny 12903 et al.*, *Aston 2180*). This variant was referred to *E. drummondii* (as *Chamaesyce drummondii*) by Hassall (1977) who recorded a chromosome number $n = 11$. We believe that this variant is better placed under *E. dallachyana* as it is morphologically similar in seed sculpturing, and stipule and leaf form. Further collections and field studies are warranted to establish the significance of this variation.

15. Euphorbia drummondii Boiss., *Cent. Euphorb.* 14 (1860); *E. drummondii* Boiss. var. *drummondii*, Baillon, *Adansonia* 6: 285 (1866); *Chamaesyce drummondii* (Boiss.) Soják, *Čas. Nár. Muz., Odd. Přír.* 140: 169 (1972). **Type:** [Western Australia.] Swan River, *s.d.*, [*J.*] *Drummond 670* (holo: G 191672 *n.v.* [image seen]; iso: G 191671 *n.v.* [image seen], K 186497, P 313102).

Monoecious, annual or herbaceous perennial with short-lived stems produced from slender woody taproot, to 15 cm high, few to many stems arising from rootstock, the whole plant glabrous. **Stems** prostrate or erect, sparingly branched, longitudinally ridged. **Interpetiolar stipules** subulate, 0.5–0.9 mm long, deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.5–1.1 mm long, smooth; blade narrow-oblong to oblong, broad-ovate or oblanceolate , sometimes slightly falcate, 4.5–16 mm long, 2.3–5 mm wide, 1.7–5 times longer than wide; adaxial and abaxial surfaces blue-green or red, smooth (rarely minutely papillose); base asymmetric with one side cordate, the other obtuse to rounded; margin serrulate; apex rounded. **Cyathia** solitary at the upper nodes, often clustered on short leafy lateral branchlets; peduncles *c.* 0.7 mm long. **Involucres** campanulate, 0.6–0.7 mm long, 0.8–1 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin entire or fimbriate; glands 4, stipitate, cupuliform, with distinct central pit and thickened rim; transverse-oblong or orbicular in outline, 0.15–0.2 mm long, 0.2–0.4 mm wide, yellow; gland appendages inconspicuous, spreading radially, transverse-linear, to 0.1 mm long, 0.4–0.5 mm wide, white, glabrous, margin entire; bracteoles 0.5–0.6 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into few to numerous, subulate hirsute segments. **Staminate flowers** 5–8 per cyathium; pedicels 0.7–1.1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, ascending, smooth, glabrous, entire or scarcely bifid, the apices clavate. **Capsules** exserted from involucre on pedicel to 2.5 mm long, broad-elliptic in lateral view, 1.6–1.8 mm long, 1.7–1.9 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** oblong-ovate in outline, 1.1–1.6 mm long, 0.8–0.9 mm tangentially, 0.7–0.9 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces concave; all faces with 3–6 distinct transverse ridges; exotesta thin, of ± even thickness over surface, grey-white, microreticulate or minutely granulate, becoming mucilaginous when moistened; endotesta red-brown. $n = 11$. **Figs 4, 25N.**

***Additional selected specimens examined*: Western Australia.** Karijini N.P., 9.2 km E of Mt Bruce, 8.5 km S of Mt Oxer, 8.7 km WNW of Mt Howieson, Mt Bruce Flats, May 1992, *van Leeuwen 1185* (PERTH); 9 km N of West Angela Hill, Hamersley Ranges, Jul 1997, *Trudgen 16679* (PERTH); 33 miles [*c.* 53 km] NE of Cosmo Newbery on road to Warburton, Aug 1962, *George 3755* (PERTH); Kurrajong Rockhole, N end of Hunt Range, May 1978, *Keighery 1747* (PERTH); near Cunderdin, Feb 1963, *Aplin 2205* (MEL, PERTH); Lapsley's property, near Dulyalbin Rock, S of Moorine Rock, Jan 1984, *Dodd 91* (PERTH). **Northern Territory.** Simpson Gap, Feb 2009, *Albrecht 12733* (BRI); Heavitree Range, base of road to Telecom West Gap Tower road, Nov 1986, *Thomson s.n.* (DNA A80432); SE [of] White Range, Arltunga Historical Reserve, May 1980, *Kalotas 482* (DNA); Kings Canyon, 'Garden of Eden', Jul 1981, *Thomson 45* (DNA). **Queensland.** MITCHELL DISTRICT: *c.* 9.5 km E of Warang homestead, site on track to the Sandstone Wall. White Mountains N.P., 57 km by road N from Torrens Creek, Apr 2000, *Thomas 1483 & Thompson* (BRI); Leander Station, Longreach, Apr 1977, *Greenfield JT893* (BRI); Milo Station, NNW of Adavale, Aug 2009, *Forster PIF35305 & Thomas* (BRI). LEICHHARDT DISTRICT: near junction of Old Rig road and Mapala – Glenhaughton Road, *c.* 75 km NW of Taroom, Mar 2004, *Halford Q8214 & Edginton* (BRI); 60 km WNW of Taroom, Glenhaughton Road, Mar 2004, *Halford Q8191 & Edginton* (BRI). WARREGO DISTRICT: 5 km SE of Charleville, Mulga Master site, Charleville experimental Reserve, Apr 1972, *Everist 9842* (BRI). MARANOA DISTRICT: 11 km SE of Gradule, W of Goondiwindi, Sep 2001, *Bean 17825* (BRI). **New South Wales.** Mulwarrina Creek, Mulgowen Station, 35 miles [*c.* 56 km] S of Bourke, Oct 1963, *Constable 4568B* (NSW); N side of Mt Gunderbooka, Nov 1987, *Wilson 163 & Wilson* (NSW); 5.6 km W of Girilambone, Mitchell Highway between Nyngan and Coolabah, Aug 1987, *Wiecek 35 et al.* (NSW); 4 miles [*c.* 6 km] NW of Girilambone, on Mitchell Highway, Sep 1968, *Thompson s.n.* (NSW 520554); Forbes District, Apr 1899, *Cox s.n.* (NSW 541459).

***Distribution and habitat*:** *Euphorbia drummondii* occurs widely and disjunctly across mainland Australia from the Pilbara region and south-western WA, through southern NT to central and southern Qld, and northern NSW (**Map 15**). It grows in open eucalypt/*Acacia* dominated communities on well drained sandy to clay-loam soils, usually on rocky hills, plains and alluvial flats.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from March to August.

***Typification*:** The isotype (*Drummond 670*) at Kew consist of two sheets (186497, 186498). The specimen on sheet 186497 matches the holotype and isotypes at G and P, while specimen on sheet 186498 is referable to *E. dallachyana* as applied here.

***Notes*:** *Euphorbia drummondii* is characterised by the following features: the whole plant glabrous, stems longitudinally ridged, glands cupuliform with distinct central pit and thickened rim, gland appendages although small (to 0.1 mm long) always present, transverse-linear with entire margins; seed surfaces with 3–6 distinct transverse ridges, capsules broad-elliptic in lateral view, and styles short (0.2–0.3 mm long), entire or scarcely bifid with somewhat thick clavate apices.

The name *Euphorbia drummondii* has been widely applied in the past. This wide application of the name starts with Bentham (1873) whose concept of *E. drummondii* included three previously recognised species (*E. ferdinandi*, *E. dallachyana*, *E. sharkoensis*). The need to recognise a wider range of taxa has become obvious from the specimens collected since Bentham's work. Fitzgerald (1918), Ewart & Kerr (1926), Domin (1927) and Hassall (1977) started to unravel this unwieldy complex when they reinstated previously named species or described new ones. Hassall (1977) proposed a number of subspecies and varieties for the species, but these were never validly published. We have reinstated *E. ferdinandi* and *E. sharkoensis* as distinct species and recognised eleven new species that have not previously been recognised as distinct from *E. drummondii*. These are: *E. albrechtii*, *E. flindersica*, *E. gregoriensis*, *E. hassallii*, *E. multifaria*, *E. papillata*, *E. papillifolia*, *E. philochalix*, *E. porcata*, *E. verrucitesta* and *E. victoriensis*.

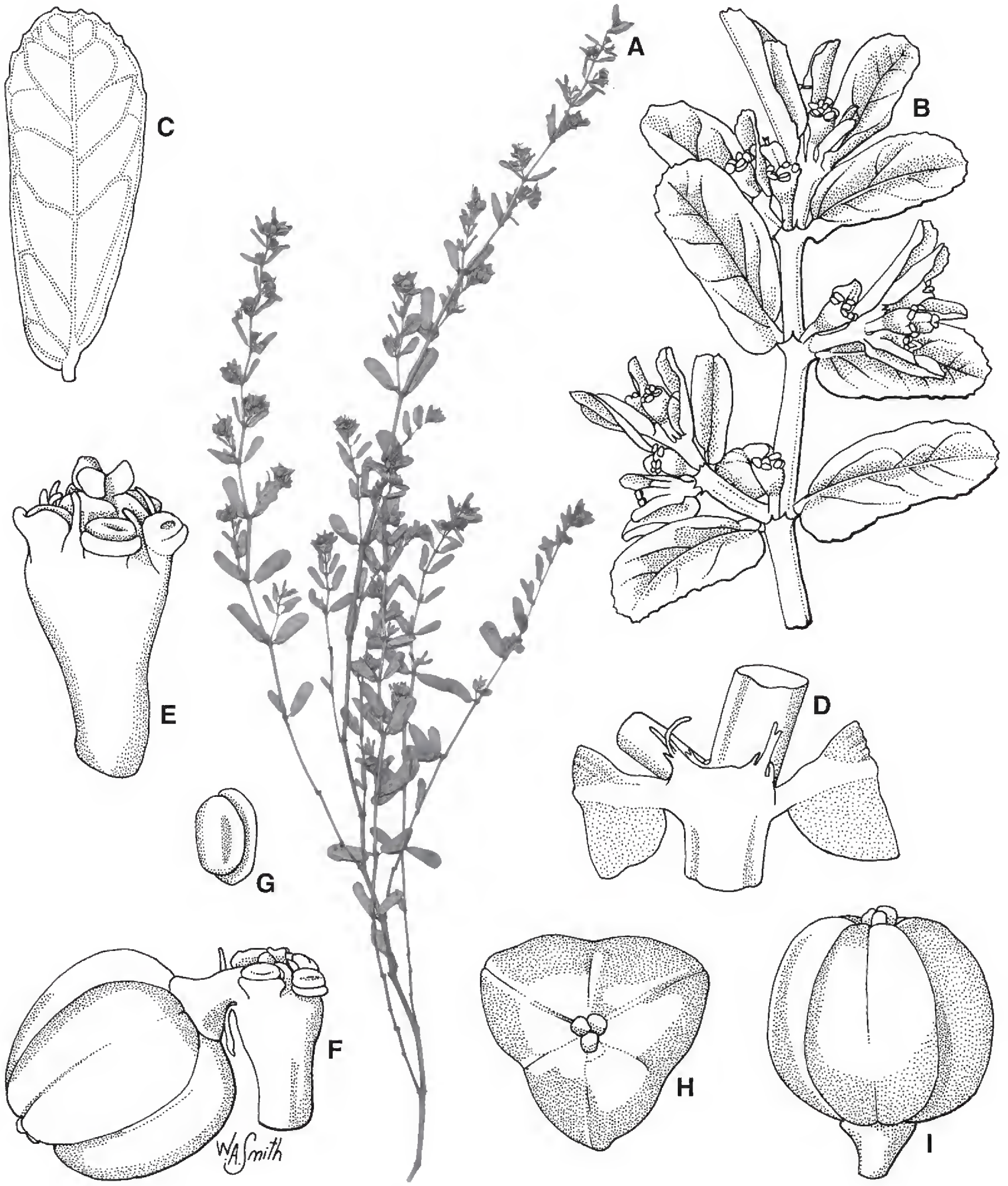

Fig. 4. ***Euphorbia drummondii.*** A. habit ×0.8. B. branchlet with cyathia ×4. C. leaf ×4. D. stipules ×12. E. cyathia with female flower ×24. F. capsule with cyathia ×16. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A & C from *Halford Q8191 & Edginton* (BRI); B, D–I from *Forster PIF35305 & Thomas* (BRI). Del.W. Smith.

16. Euphorbia ferdinandi Baill., *Adansonia* 6: 284–285 (1866). **Type:** [New South Wales.] Mt Goningberri [Koonenberry Mountain], 31 December 1860, NE Exped. [*H.Beckler s.n.*] (holo: P 313103; iso: MEL 2179535).

Monoecious, herbaceous perennial, to 10 cm high, few to many annual stems arising from woody taproot, the whole plant glabrous. **Stems** prostrate or decumbent to ascending, sparingly to much branched, smooth or sometimes longitudinally ridged. **Interpetiolar stipules** subulate, narrow-triangular or triangular, 0.3–1.2 mm long, bifid or deeply bipartite, glabrous; margin shallowly to deeply laciniate. **Leaves**: petiole 0.2–0.8 mm long, smooth; blade obovate, oblong-obovate, oblong or elliptic, 3–8 mm long, 1.4–4.2 mm wide, 1.4–2.5 times longer than wide; adaxial and abaxial surfaces green or blue-green (sometimes with reddish tinge especially on margins), smooth or papillose; base asymmetric with one side cordate to rounded, the other cuneate to obtuse; margin sparingly minutely toothed distally or entire; apex rounded. **Cyathia** solitary at the nodes, sometimes clustered on short leafy lateral branchlets; peduncles 0.2–0.5 mm long. **Involucres** turbinate to campanulate, 0.5–0.9 mm long, 0.6–1 mm across; lobes 5, triangular, 0.15–0.5 mm long, margin entire or fimbriate; glands 4, stipitate, cupuliform, with distinct central pit and thickened rim, transverse-elliptic or orbicular in outline, 0.1–0.3 mm long, 0.1–0.4 mm wide, pink, orange to red or yellowish green; gland appendages mostly absent, rarely present, spreading radially, transverse-linear, to 0.1 mm long, 0.3–0.4 mm wide, red or white, glabrous, margin entire; bracteoles 0.5–0.8 mm long, adnate for 1/3 of their length to involucre, free portion either an entire subulate glabrous lobe or divided into few to numerous subulate glabrous or hirsute segments. **Staminate flowers** 3–5 per cyathium; pedicels 0.7–1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.2–0.4 mm long, spreading or ascending to erect, smooth, glabrous, entire (rarely scarcely bifid, *Halford Q9212* [BRI]), the apices terete or clavate. **Capsules** exserted from involucre on pedicel to 1.7(2.5) mm long, elliptic in lateral view, 1.4–2.1 mm long, 1.2–1.7 mm across, shallowly 3-lobate with keels obtuse to acute, smooth or papillose, glabrous; hypogynous disc entire. **Seeds** narrow-ovate in outline, 1.1–1.6 mm long, 0.5–0.7 mm tangentially, 0.4–0.6 mm radially, tetraquetrous in cross section; dorsal faces planar or concave; ventral faces concave; all faces smooth; exotesta thin, of even thickness, pale brown or white, microreticulate or minutely granulate, becoming mucilaginous when moistened; endotesta brown or red-brown.

Distribution: *Euphorbia ferdinandi* is widespread in arid Australia from near Wiluna and Laverton, WA, eastward through the NT and SA to western Qld and north-western NSW, with disjunct populations near Tom Price, Pilbara, WA.

Notes: Bentham (1873) placed *Euphorbia ferdinandi* in synonymy under *E. drummondii*. Subsequently the name *E. drummondii* has been widely applied to this species. *Euphorbia ferdinandi* differs from *E. drummondii*, in having smooth seeds (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*) and capsules distinctly longer than wide (capsules elliptic in lateral view, 1.4–2.1 × 1.2–1.7 mm versus broad-elliptic in lateral view, 1.6–1.8 × 1.7–1.9 mm for *E. drummondii*).

As recognised here, *E. ferdinandi* is variable in degree of gland appendage development and size of capsules and seeds. This has led us to recognise three varieties which can be distinguished by the following key.

Key to varieties of *Euphorbia ferdinandi*

1 Gland appendages present . . . . **16b. E. ferdinandi** var. **appendiculata**
1. Gland appendages absent **2**

2 Capsules 1.4–1.9 × 1.3–1.7 mm, <1.3 times long as wide, distinctly minutely papillose (visible at 40× mag.); seeds 1.1–1.3 mm long . . . . **16a E. ferdinandi** var. **ferdinandi**
2. Capsules 1.8–2.1 × 1.2–1.5 mm, ≥1.3 times as long as wide, faintly minutely papillose (visible at 40× mag.); seeds 1.4–1.6 mm long . . . . **6c. E. ferdinandi** var. **saxosiplaniticola**

16a. Euphorbia ferdinandi var. ferdinandi

Stems prostrate or decumbent, sometimes longitudinally ridged. **Leaves**: petiole 0.2–0.8 mm long; blade obovate or oblong-obovate, 3.4–8 mm long, 1.4–4.2 mm wide, 1.9–2.5 times longer than wide; adaxial and abaxial surfaces papillose; margin sparingly minutely toothed distally or entire. **Involucres** turbinate to campanulate, 0.7–0.8 mm long, 0.8–1 mm across; gland appendages absent. **Pistillate flowers**: styles 0.2–0.4 mm long, entire or rarely scarcely bifid, with terete apices. **Capsules** 1.4–1.9 mm long, 1.3–1.7 mm across, papillose (sometimes only minutely so and may appear smooth without 40× mag.). **Seeds** 1.1–1.3 mm long, 0.5–0.7 mm tangentially, 0.5–0.6 mm radially. *n* = 11. **Figs 5, 25O.**

Additional selected specimens examined: Western Australia. Warburton, Oct 1963, *de Graff s.n.* (PERTH 2437104); Mt Eveline, E of Warburton, Aug 1962, *George 3869* (PERTH); 28 miles [*c.* 45 km] N of Warburton, Jul 1963, *George 5315* (PERTH); 35 km W of NT/WA border on Lasseter Highway, Apr 1992, *Zich 46* (NSW). **Northern Territory.** Barkly Highway, May 1993, *Egan 2232* (DNA); Stirling/Ti Tree boundary, May 1979, *Kalotas 354* (DNA); Hermannsburg Road, 52 km E of Hermannsburg, Aug 1988, *Barritt 454* (DNA); eastern Golfcourse suburb, 4 km E Alice Springs, Mar 1988, *Barritt 22* (DNA, MEL); Hamilton Downs Road, 14 miles [*c.* 22 km] NW [of] Alice Springs, Jan 1964, *Nelson 843* (DNA, NSW); Finke Road, 6 km E of Wellmullinna Creek, Aug 1988, *Barritt 602* (DNA, MEL). **Queensland.** BURKE DISTRICT: 12.5 km SE of Malbon, May 1985, *Neldner 1687 & Stanley* (BRI). GREGORY NORTH DISTRICT: Moonah Creek, 7 km E of Oban homestead, May 1985, *Neldner 2250 & Stanley* (BRI). WARREGO DISTRICT: Currawinya N.P., Thargomindah turnoff on Eulo to Hungerford Road, Mar 1997, *Forster PIF20367 & Watson* (BRI). GREGORY SOUTH DISTRICT: 117 miles [*c.* 188 km] NW of Quilpie on Windorah Road, May 1975, *Hassall 7514* (BRI). **South Australia.** *c.* 6.5 km by road NNE of turnoff from Pipalyatjara road, on road to Waltjitjata, Tomkinson Ranges, Sep 1978, *Stove 487* (AD); Patchawara Bore, Innamincka Station, Nov 1987, *Conrick 2220* (AD, MEL); 13.5 km by road SSE of Duff Creek crossing and 52 km NNW of William Creek Hotel on Oodnadatta track, Mar 1984, *Donner 9924* (AD); 3 km N of Carl Dour Tank, Mobella Station, Aug 1995, *Badman 7920* (AD); 23 km SE of Lake Bring, Oct 1987, *Symon NPWS1443* (AD). **New South Wales.** Depot Glen, 12 km N of Milparinka, Oct 1976, *Pickard 3142* (NSW); Stud Creek, Gorge Loop Road, Sturt N.P., Aug 1991, *Duncan s.n.* (NSW 249230).

Distribution and habitat: *Euphorbia ferdinandi* var. *ferdinandi* is widespread in central Australia from near Wiluna and Laverton, WA, eastward through NT and SA to western Qld and north-western NSW, with disjunct populations near Tom Price, Pilbara, WA (**Map 16a**). It grows on sandy to sandy loam soils in *Acacia* shrubland/woodland or hummock grassland communities, mostly on plains or along watercourses, rarely on sandstone escarpments.

Phenology: Flowers and fruits have been collected throughout the year, particularly from May to October.

16b. Euphorbia ferdinandi var. appendiculata Halford & W.K.Harris, varietas nova

ab aliis varietatibus *E. ferdinandi* Baill. appendicibus glandulis praesentibus et etiam habitu foliisque minoribus differt. **Typus:** Queensland. GREGORY NORTH DISTRICT: 42 km S along Old Cork Road from Winton – Boulia Road, 24 September 2005, *D.Halford Q8604 & M.B.Thomas* (holo: BRI; iso: AD, MEL).

Stems prostrate or rarely decumbent to ascending, longitudinally ridged. **Leaves**: petiole 0.3–0.7 mm long; blade oblong or elliptic, 3–6 mm long, 1.6–3.6 mm wide, 1.4–2 times longer than wide; adaxial surface smooth (rarely faintly papillose); abaxial surface smooth; margin entire. **Involucres** campanulate, 0.5–0.8 mm long, 0.6–0.8 mm across; gland appendages inconspicuous, transverse-linear, to 0.1 mm long, 0.3–0.4 mm wide. **Pistillate flowers**: styles 0.2–0.3 mm long, entire, with clavate apices. **Capsules** 1.7–2 mm long, 1.3–1.6 mm across, smooth or rarely faintly papillose. **Seeds** 1.3–1.4 mm long, 0.5–0.6 mm tangentially, 0.5–0.6 mm radially. *n* = 11. **Fig. 25P.**

Additional selected specimens examined: **Northern Territory.** Hamilton Downs Station, Jan 1987, *Thomson 1736* (DNA); Burt Plain, 60 km N of Alice Springs, Sep 1986, *Thomson 1468* (DNA). **Queensland.** MITCHELL DISTRICT: Idalia N.P., SW of Blackall, Jun 1990, *Rogers s.n.* (BRI [AQ624140]). GREGORY NORTH DISTRICT: Diamantina N.P., track to Scotts Tank, Apr 1997, *Forster PIF20678 & Holland* (BRI); 153 km S of Boulia, May 1976, *Hassall 7649* (BRI). WARREGO DISTRICT: *c.* 40 miles [*c.* 64 km] S of Charleville on Cunnamulla Road, Aug 1973, *Hassall 7384* (BRI); Currawinya N.P., Paroo River floodplain south of Caiwarra ruins, Mar 1997, *Forster PIF20507 & Watson* (BRI); Currawinya N.P., north of Hungerford, Apr 1994, *Swain 604* (BRI); 33.5

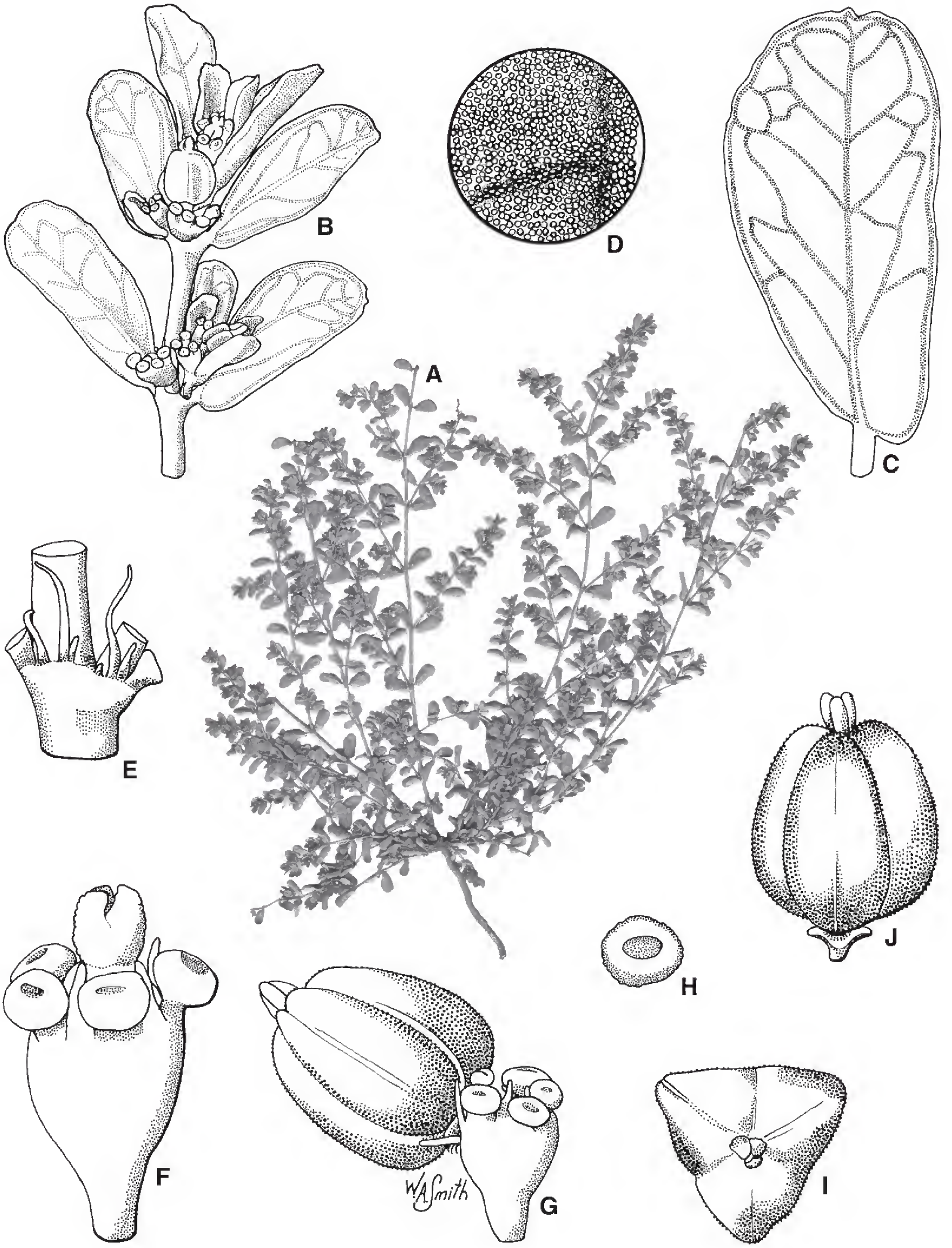

Fig. 5. ***Euphorbia ferdinandi*** **var.** ***ferdinandi***. A. habit ×0.6. B. branchlet with cyathia ×6. C. leaf ×8. D. papillae on lower leaf surface ×32. E. stipules ×16. F. cyathia with female flower ×32. G. capsule with cyathia ×16. H. cyathial gland, adaxial view ×32. I. capsule, top view ×16. J. capsule, lateral view ×16. A from *Barritt 454* (DNA); B–J from *Kalotas 354* (DNA). Del. W.Smith.

km E of Eulo, towards Cunnamulla, Aug 2006, *Bean 25669* (BRI). Gregory South District: *c.* 9 km due W of Tickalara homestead, *c.* 170 km SW of Thargomindah, 1995, *Kemp 895 & Fairfax* (BRI). **South Australia.** 25.7 km from Birdsville road, E of Macumba homestead, Browns Creek, Sep 1986, *Ballingall 2238* (BRI); *c.* 65 km N of Innamincka, Aug 1975, *Weber 4680* (AD); Marree, Jun 1930, *George s.n.* (AD 98597032); Myall Well, Andamooka Station, Oct 1989, *Badman 3862* (AD). **New South Wales.** walking track *c.* 2.25 km from Mt Wood summit, Sturt N.P., Sep 1989, *Wiecek 313 et al.* (NSW); Rossmore Station, 20 miles [*c.* 32 km] NE of Bourke, Oct 1963, *Constable 4481* (NSW).

***Distribution and habitat*:** *Euphorbia ferdinandi* var. *appendiculata* occurs from near Alice Springs, NT, north east to Julia Creek, Qld, south to north-eastern SA and east to Bourke, western NSW (**Map 16b**). It commonly grows in grassland communities on cracking clay soils, or chenopod shrubland communities on stony clay soils on plains or alluvial flats.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia ferdinandi* var. *appendiculata* differs from the other varieties by having gland appendages and it is also generally smaller in habit and leaves.

***Etymology*:** The varietal epithet is Latin *appendiculatus,* with small appendages, in reference to the presences of gland appendages in this variety.

16c. Euphorbia ferdinandi var. **saxosiplaniticola** Halford & W.K.Harris, **varietas nova** ab *E. ferdinandi* Baill. var. *ferdinandi* capsulis angustioribus et plerumque longioribus 1.8–2.1 × 1.2–1.5 mm ≥1.3 plo longioribus quam latioribus tantum minute papillosis (in vicem 1.4–1.9 × 1.3–1.7 mm <1.3 plo longioribus quam latioribus distincte minute papillosis), seminibus longioribus 1.4–1.6 mm longis (in vicem 1.1–1.3 mm longis) necnon *E. ferdinandi* var. *appendiculata* Halford & W.K.Harris appendices glandulae carens differt. **Typus:** South Australia. Poonia Waterhole, 5 September 1986, *J.S.Weber 9140* (holo: AD; iso: three duplicates to be distributed).

Stems prostrate or decumbent. **Leaves**: petiole 0.3–0.5 mm long; blade oblong, obovate or elliptic, 4.2–7 mm long, 2.1–3 mm wide, 2.3–2.5 times longer than wide; adaxial and abaxial surfaces smooth; margin entire or sparingly minutely toothed distally. **Involucres** turbinate, 0.8–0.9 mm long, 0.6–0.7 mm across; gland appendages absent. **Pistillate flowers**: styles 0.2–0.3 mm long, entire, with terete apices. **Capsules** 1.8–2.1 mm long, 1.2–1.5 mm across, smooth or faintly papillose. **Seeds** 1.4–1.6 mm long, 0.5–0.7 mm tangentially, 0.4–0.5 mm radially. **Fig. 25Q.**

***Additional selected specimens examined*:** **Northern Territory.** Allitra Tableland, Simpson Desert, Aug 1992, *Latz 12450* (DNA); Mac Clarke Reserve, Andado Station, Aug 1992, *Coulson 61 & Latz* (DNA); Mt Wilyunpa, Aug 1992, *Coulson 35* (DNA); Alice Springs, Andado Station, Aug 1997, *Michell 391 & Calliss* (DNA). **South Australia.** Pedirka, Aug 1932, *Ising* (AD 966031149); Minnie Downs, Apr 1924, *Reese 130* (AD); 8 km SSW of homestead, Dulkaninna Station, Dec 1995, *Badman 8796* (AD).

***Distribution and habitat*:** *Euphorbia ferdinandi* var. *saxosiplaniticola* occurs in central Australia from Allitra Tableland, NT southward to near Maree, SA (**Map 16c**). It grows on clay soils on gibber plains or tablelands.

***Phenology*:** Flowers and fruits have been collected in April, August, September and December.

***Notes*:** *Euphorbia ferdinandi* var. *saxosiplaniticola* differs from *E. ferdinandi* var. *ferdinandi* in having narrower and generally longer capsules, 1.8–2.1 mm long by 1.2–1.5 mm wide, ≥1.3 times as long as wide, that are only faintly minutely papillose (versus capsules 1.4–1.9 mm long by 1.3–1.7 mm wide, <1.3 times long as wide, that are distinctly minutely papillose for *E. ferdinandi* var. *ferdinandi*) and longer seeds 1.4–1.6 mm long (versus seeds 1.1–1.3 mm long for *E. ferdinandi* var. *ferdinandi*). *Euphorbia ferdinandi* var. *saxosiplaniticola* differs from *Euphorbia ferdinandi* var. *appendiculata* in lacking glandular appendages.

***Etymology*:** The varietal epithet is from Latin *saxosa*, rocky or stony places, *planities*, flat surface, plain, and *-cola*, dweller or inhabitant, in reference to the gibber plains of Central Australia where this variety has been recorded growing.

17. Euphorbia fitzroyensis Halford & W.K.Harris, **species nova** similis *E. drummondii* Boiss. et *E. hassallii* Halford & W.K.Harris a duabus autem superficiebus seminum porcis 6–9 angustis rotundatis transversis (ad vicem porcis 3–6 transversis in *E. drummondii* et porcis 3–5 prominentibus rotundatis transversus irregularisque in *E. hassallii*) necnon ab *E. drummondii* stylis 1/3–1/2 longitudinis bifidis (ad vicem stylis integris vel vix bifidis) et exotesta manifeste crassa in porcis transversis (ad vicem exotesta aeque crassa in superficie seminum) differt. **Typus:** Western Australia. Liveringa Station, near Fitzroy River, 20 April 1985, *T.E.H.Aplin 172 et al.* (holo: PERTH).

Monoecious, annual to 30 cm high, few to many stems arising from rootstock, the whole plant glabrous. **Stems** erect, sparingly to much branched, longitudinally ridged. **Interpetiolar stipules** subulate or narrow-triangular, 0.4–0.8 mm long, deeply bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 0.3–0.5 mm long, smooth; blade narrow-oblong, 5–9 mm long, 1.5–3.1 mm wide, 2.5–4.2 times longer than wide; adaxial and abaxial surfaces colour unknown, smooth or minutely papillose (visible at 40× mag.); base asymmetric with one side cordate, the other obtuse; margin entire or sparingly minutely toothed distally; apex rounded or obtuse. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.2–1.4 mm long. **Involucres** turbinate, 0.5–0.8 mm long, 0.4–0.6 mm across; lobes 5, triangular, 0.3–0.4 mm long, margin entire; glands 4, stipitate, cupuliform, with distinct central pit, transverse-oblong in outline, 0.1–0.15 mm long, 0.2–0.4 mm wide, colour unknown; gland appendages inconspicuous, spreading radially, transverse-linear; *c.* 0.05 mm long and 0.35 mm wide, glabrous, colour unknown, margin entire; bracteoles 0.6–0.8 mm long, adnate for 1/4 of their length to involucre, free portion entire subulate glabrous. **Staminate flowers** 2–4 per cyathium; pedicels 0.8–1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, spreading or ascending, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices clavate or terete. **Capsules** exserted from involucre on pedicels to 2 mm long; broad-elliptic in lateral view, 1.6–1.8 mm long, 1.6–1.7 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** narrow-ovate in outline, 1.2–1.4 mm long, 0.7–0.8 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces planar or concave; all faces with 6–9 prominent narrow rounded transverse ridges; exotesta of uneven thickness, distinctly thicker on transverse ridges, white or pale brown, microreticulate; endotesta brown or red-brown. **Figs 6, 25R.**

***Additional specimens examined*: Western Australia.** Fitzroy River crossing, S of Derby, May 1991, *Thomson 3475* (NT); Fitzroy River, Aug 1906, *Fitzgerald s.n. 1567* (PERTH); Fitzroy River, Aug 1906, *Fitzgerald* (NSW 521748); Liveringa, Jan 1953, *Broadbent 590* (BM); Geikie Gorge N.P., Jul 1974, *Carr 3803 & Beauglehole 47581* (NSW, PERTH); Gogo Station, Fitzroy Crossing, May 1962, *Royce 7005* (PERTH).

***Distribution and habitat*:** *Euphorbia fitzroyensis* is confined to the vicinity of the Fitzroy River, WA (**Map 17**). It grows on alluvial plains in eucalypt woodland communities on heavy loam to silty clay soils, and in *Triodia* grassland communities on sandy soils.

***Phenology*:** Flowers and fruits have been collected from April to August.

***Notes*:** *Euphorbia fitzroyensis* is similar to *E. drummondii* and *E. hassallii*. It differs from both species by having seed surfaces with 6–9 narrow rounded transverse ridges (versus 3–6 transverse ridges for *E. drummondii*, and 3–5 prominent rounded transverse or irregular ridges for *E. hassallii*). It also differs from *E. drummondii* in having styles bifidly divided for 1/3–1/2 of their length (versus styles entire or scarcely bifid for *E. drummondii*) and exotesta is distinctly thicker on transverse ridges (versus exotesta is of even thickness over seed surface for *E. drummondii*).

The collection (*Royce 7005*) is tentatively placed here. Although its general form, leaf shape, involucral glands and seeds are consistent with *E. fitzroyensis*, it differs in having stems lacking longitudinal ridges.

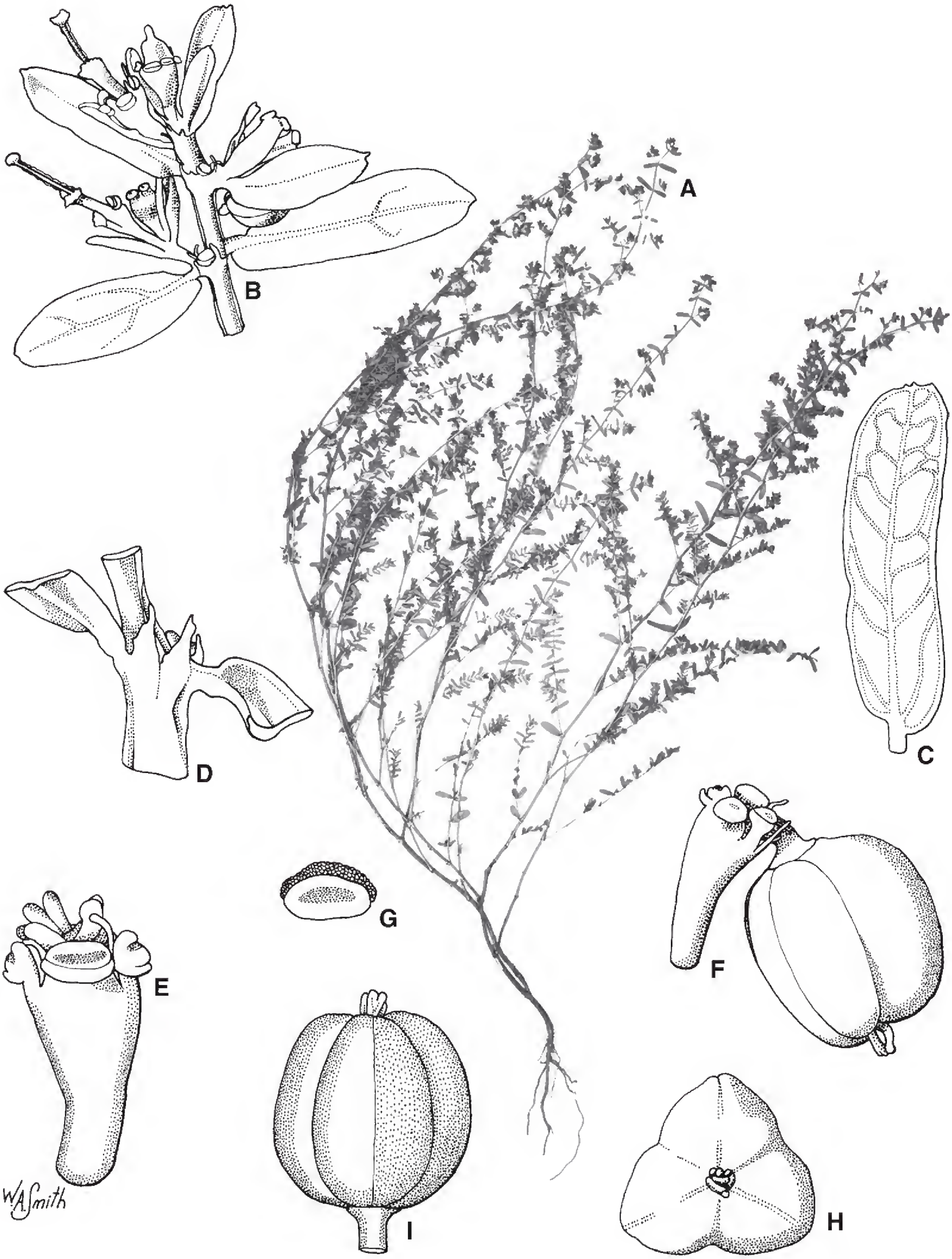

Fig. 6. *Euphorbia fitzroyensis*. A. habit ×0.4. B. branchlet with cyathia ×8. C. leaf ×6. D. stipules ×16. E. cyathia with female flower ×32. F. capsule with cyathia ×16. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A–I from *Aplin 172* (PERTH). Del. W.Smith.

***Etymology*:** The specific epithet refers to the Fitzroy River area in the Kimberley, WA where the species occurs.

18. Euphorbia flindersica Halford & W.K.Harris, *J. Adelaide Botanic Gardens* 24: 43–45 (2010). **Type:** South Australia. Mt Gee, 15 September 1973, *R.H.Kuchel 3169* (holo: AD).

***Illustration*:** Halford & Harris (2010: 44, fig. 1).

Monoecious, herbaceous perennial to 10 cm high, with short-lived stems produced from thick somewhat woody rootstock, the whole plant glabrous. **Stems** prostrate to erect, much branched, smooth or faintly papillose. **Interpetiolar stipules** triangular 0.4–0.6 mm long, deeply bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 0.2–1.2 mm long, smooth; blade oblong or obovate, 1.3–6.7 mm long, 1–3.8 mm wide, 1.5–1.8 times longer than wide, both surfaces minutely papillose (visible at 40× mag.); adaxial surface mostly green sometimes with reddish tinge on margin; abaxial surface grey; base strongly asymmetric with one side cordate to rounded, the other cuneate to rounded; margins entire or sparsely minutely toothed distally; apex rounded. **Cyathia** solitary at the nodes; peduncles 0.3–0.7 mm long. **Involucres** campanulate or cupuliform, 0.8–1 mm long, 0.6–1.2 mm across; lobes 5, triangular, 0.3–0.4 mm long, margins ciliate; glands 4, shortly stipitate, patelliform, planar or shallowly concave, transverse-oblong to transverse-elliptic, 0.1–0.3 mm long, 0.3–0.5 mm wide, red or yellowish green; gland appendages conspicuous, spreading radially, obdeltoid, 0.3–0.4 mm long, 0.6–0.8 mm wide, pink or red, glabrous, dentate or irregularly lobed; bracteoles 0.5–0.9 mm long, adnate for 1/3 of their length to involucre, free portion divided into few to numerous subulate glabrous segments. **Staminate flowers** 10–15 per cyathium; pedicels 0.7–1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles *c.* 0.5 mm long, spreading, smooth, glabrous, each bifid to 1/4–1/3 of their length, apices slender terete. **Capsules** exserted from involucre on pedicel to 2.7 mm long, ovate to broad-ovate in lateral view, 1.5–1.8 mm long, 1.7–2.2 mm across, shallowly 3-lobate with keels acute, papillose; hypogynous disc entire. **Seeds** ovate in outline, 1.1–1.3 mm long, 0.7–0.8 mm tangentially, 0.6–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces planar or shallowly convex; all faces smooth or with faint irregular ridges; exotesta thin, of even thickness, cream or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta reddish brown. $n = 11$. **Fig. 26A.**

***Additional selected specimens examined*: South Australia.** Gorge Creek of Myrtle Springs, *c.* 24 km NW of Leigh Creek, Sep 1962, *Lothian 1077* (AD); Paralana Springs, 125 km NE of Blinman, Aug 1968, *Carrick 2059* (AD); south branch of Paralana Hot Springs Creek, Aug 1964, *Saddler s.n.* (AD 96532103); Nepouie Springs, Apr 1994, *Bates 37341* (AD); Grindell Hut, Balcanoona Station, July 1980, *Williams 11205* (AD); Italowie Creek, Aug 1979, *Conrick AD100* (AD); Chambers Gorge, near Mt Chambers, *c.* 60 km ENE of Blinman, Sep 1956, *Eichler 12559* (AD); Chambers Gorge, *c.* 80 km ENE of Parachilna, Sep 1973, *Whibley 3922* (AD); Parachilna Gorge, Aug 1963, *Sharrad 1404* (AD); upper Bunyeroo Gorge, *c.* 50 km NNE of Hawker, Oct 1958, *Kraehenbuehl 14* (AD); The Bunkers, Bunkers Range, Apr 1989, *James 16* (AD); Arkaroola Sanctuary, Ridge Top road, Oct 1971, *Kuchel 3039* (AD); western portion [of] Oraparinna N.P., Sep 1971, *Weber 2710* (AD); Brachina Gorge, Sep 1961, *Symon 1400* (AD); Moralana Station, road & rail crossing Bunyeroo Creek, Jul 1987, *Symon 14628* (AD); Arkaba Station, Oct 1925, *Beck s.n.* (AD 96938301).

***Distribution and habitat*:** *Euphorbia flindersica* is restricted to the northern Flinders Ranges, SA, occurring from near Leigh Creek to Hawker (**Map 18**). It grows on sandy clay soils on rocky outcrops or gravelly hill slopes.

***Phenology*:** Flowers and fruits have been collected from April to October.

***Notes*:** *Euphorbia flindersica* is similar to *E. ferdinandi* and *E. papillata* in having papillose capsules and leaves but differs from both in having involucral glands patelliform, planar or shallowly concave (versus cupuliform, with distinct central pit and thickened rim for *E. ferdinandi* and *E. papillata*).

Euphorbia multifaria and *E. verrucitesta* overlap the distributional range of *E. flindersica* and all three species were previously included in *E. drummondii s.l.* in SA (Weber 1986). *Euphorbia flindersica* differs from these species by its planar or shallowly concave involucral glands, larger and conspicuous gland appendages, 0.3–0.4 mm long, which are dentate or irregularly lobed.

Hassall (1977) proposed the name *E. drummondii* subsp. *blackii* for this taxon but this name was never validly published.

19. Euphorbia gregoriensis Halford & W.K.Harris, **species nova** similis *E. schultzii* var. *comanti* (W.Fitzg.) Halford & W.K.Harris in habitu et indumento et forma foliorum et in amplitudine differt autem capsulis angustioribus (1.9–2 mm) longitudine latitudinem aequi leviter 3-lobatis (ad vicem 2–3 mm latis manifeste latioribus quam latioribus profunde 3-lobatis). Similis *E. hassallii* Halford & W.K.Harris in forma capsularum differt autem exotesta inaequaliter crassa semper crassiore in porcis (ad vicem appendicibus <0.1 mm longis aut si longioribus nunc lobatis profunde) paginis foliorum falcato-oblongis 9.8–12 × 4–6 mm <3 plo longioribus quam latiorbus (ad vicem paginis foliorum anguste oblongis vel anguste ovatis 8.2–25 × 2–4.8 mm ≥3 plo longioribus quam latis). **Typus:** Northern Territory. Gregory National Park, 14 km NE of Bullita O/S [outstation], 8 February 1986, *B.G.Thomson 1114* (holo: DNA).

Monoecious, annual to 40 cm high, one to few stems arising from base, the whole plant glabrous except for a few scattered hairs on stems proximally. **Stems** erect, sparingly branched, smooth, glabrous or sparsely hairy proximally; hairs spreading, curled or straight, 0.5–1.0 mm long, white. **Interpetiolar stipules** subulate, 0.5–1.3 mm long, bipartite, glabrous; margin entire. **Leaves**: petiole 0.5–0.8 mm long, smooth; blade falcate-oblong, 9.8–12 mm long, 4–6 mm wide, 1.8–2.7 times longer than wide; adaxial and abaxial surfaces green, minutely papillose to glabrous; base asymmetric, cordate; margin serrate at the apex and along one side or sparingly toothed distally; apex rounded or obtuse. **Cyathia** solitary at the nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.5–0.7 mm long. **Involucres** campanulate or turbinate, 0.8–1 mm long, 0.7–0.8 mm across; lobes 5, triangular, 0.5–0.6 mm long, margin fimbriate; glands 4, stipitate (*c.* 0.075 mm long), cupuliform, with distinct central pit, transverse-oblong in outline, *c.* 0.2 mm long, 0.3–0.4 mm wide, pale green or pink; gland appendages conspicuous, spreading radially, very broad-obovate, 0.1–0.4 mm long, 0.6–0.8 mm wide, pink or white, glabrous, margin entire; bracteoles *c.* 0.8 mm long, adnate for 1/3–1/2 of their length to involucre, free portion entire, subulate or divided into numerous subulate segments, glabrous. **Staminate flowers** 7–10 per cyathium; pedicels 1–1.1 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.4–0.5 mm long, ascending, smooth, glabrous, each bifid for *c.* 1/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2.5 mm long, broad-elliptic in lateral view, 1.9–2 mm long, 1.9–2 mm across, shallowly 3-lobate with keels acute, smooth or minutely papillose, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1.3–1.5 mm long; 0.8–0.9 mm tangentially, 0.8–0.9 mm radially, tetraquetrous in cross section; dorsal and ventral faces planar, with prominent broad rounded irregular ridges; exotesta of uneven thickness, distinctly thicker on ridges, white or pale brown, microtuberculate, becoming mucilaginous when moistened; endotesta brown or red-brown. **Figs 7, 26B.**

***Additional selected specimens examined*: Northern Territory.** 50 km [*c.* 80 km] S [of] Bullita O/S [outstation], Gregory N.P., Mar 1991, *Thomson 3453* (DNA, NT); 20 miles [*c.* 32 km] S [of] Timber Creek Police Station, May 1959, *Chippendale 6050* (DNA, MEL, NSW); Gregory N.P., 8 km NW of Bullita O/S [outstation], Feb 1986, *Thomson 1082* (DNA); Gregory N.P., 3 km S of Bullita O/S [outstation], Feb 1986, *Thomson 963* (DNA); Bullita Station, Gregory N.P., Feb 1986, *Wightman 2591 & Clark* (DNA); Gregory N.P, Feb 1986, *Thomson 1166* (DNA); Gregory N.P., Bullock Paddock Creek valley, Apr 1996, *O'Neill 24* (DNA); Gregory N.P., Station Hill, Feb 1992, *Cowie 2502 & Brocklehurst* (DNA); Wickham River, Mar 1992, *Brocklehurst 616* (DNA).

***Distribution and habitat*:** *Euphorbia gregoriensis* is restricted to the hills of the Gregory N.P. and Victoria River Station, NT (**Map 19**). It grows in eucalypt open woodland communities on shallow soils on

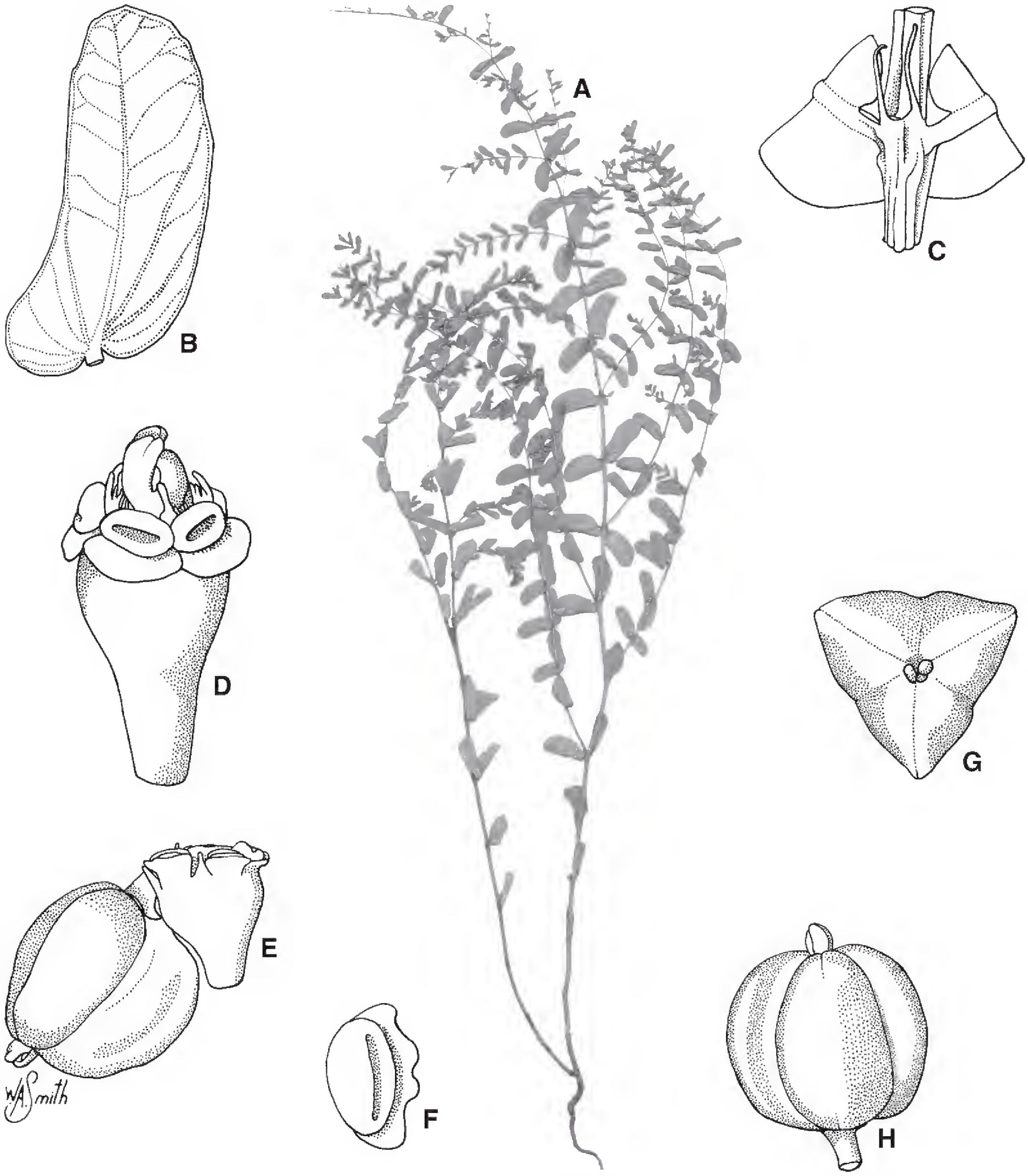

Fig. 7. ***Euphorbia gregoriensis***. A. habit ×0.4. B. leaf ×4. C. stipules ×12. D. cyathia with female flower ×24. E. capsule with cyathia ×12. F. cyathial gland with appendage, adaxial view ×32. G. capsule, top view ×12. H. capsule, lateral view ×12. A & B from *Thomson 1114* (DNA); C & D from *Thomson 1082* (DNA); E–H from *Brocklehurst 616* (DNA). Del.W. Smith.

rocky sandstone mesa tops, scree slopes or hill sides.

Phenology: Flowers and fruits have been collected from February to May.

Notes: *Euphorbia gregoriensis* is morphologically similar to *E. schultzii* var. *comans* (W.Fitzg.) Halford & W.K.Harris in habit, indumentum, and leaf shape and size, but differs by having narrower capsules (1.9–2 mm) that are as long as wide and shallowly 3-lobate (versus 2–3 mm across, distinctly broader than long and deeply 3-lobate for *E. schultzii* var. *comans*). *Euphorbia gregoriensis* is similar to *E. hassallii* in capsule shape but differs by having exotesta of uneven thickness, always thicker on ridges (versus exotesta ± of even thickness for *E. hassallii*), gland appendages >0.1 mm long and entire (versus gland appendages <0.1 mm long or if longer then appendages deeply lobed for *E. hassallii*) and leaf blades falcate-oblong, 9.8–12 × 4–6 mm, <3 times as long as wide (versus leaf blades narrow-oblong or narrow-ovate, 8.2–25 × 2–4.8 mm, ≥3 times as long as wide for *E. hassallii*).

The collection *Chippendale 6111* (3.3 miles [*c*. 5.3 km] E [of] Willeroo, May 1959 [DNA, NSW]) is tentatively referred to here as it most resembles *E. gregoriensis*. However, it is atypical in having a longitudinal band of short crispate hairs along its stems and its seeds lack the thick endotesta that is typical of this species.

Etymology: The specific epithet refers to the Gregory N.P., in the NT where the species occurs.

20. Euphorbia hassallii Halford & W.K.Harris, **species nova** similis *E. drummondii* Boiss. sed plerumque stylis longioribus 0.3–0.4 mm longis bifidis usque 1/3 longitudinis apicibus teretibus (ad vicem 0.2–0.3 mm longis integris vel vix bifidis apicibus clavatus) necnon appendicibus glandulae interdum aut carentibus aut leviter usque profunde lobatis (ad vicem appendicibus glandulae semper qui sunt <0.1 mm longis) differt. **Typus:** Northern Territory. Victoria Highway, 30 km W of Katherine, 23 December 1994, *M.J.A.Barritt 1700* (holo: BRI, iso: DNA, MEL).

Monoecious, annual or herbaceous perennial with slender taproot, to 30 cm high, few stems arising from rootstock. **Stems** erect or ascending (rarely prostrate), sparingly to much branched, smooth, sometimes longitudinally ridged, glabrous or with a sparse indumentum; hairs spreading, ± straight, 0.2–0.4 mm long, white. **Interpetiolar stipules** subulate, 0.5–1.1 mm long, deeply bipartite, glabrous; margin entire. **Leaves**: petiole 0.4–0.6 mm long, smooth, glabrous; blade narrow-oblong or narrow-ovate, 8.2–25 mm long, 2–4.8 mm wide, 3.7–8.8(32) times longer than wide; adaxial surface dark green sometimes with reddish tinge, minutely papillose, glabrous; abaxial surface paler than adaxial surface, minutely papillose, glabrous or with a sparse indumentum; hairs appressed-ascending, straight, 0.2–0.3 mm long; base asymmetric with one side cordate, the other obtuse to cordate; margin entire or sparingly minutely toothed distally; apex rounded, obtuse or acute. **Cyathia** solitary at the upper nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves, peduncles 0.3–0.5 mm long, smooth, glabrous. **Involucres** campanulate or turbinate, 0.6–0.9 mm long, 0.8–1 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin entire or fimbriate; glands 4, stipitate, cupuliform, with distinct central pit and thickened rim, transverse-oblong in outline, 0.1–0.2 mm long, 0.3–0.5 mm wide, red; gland appendages conspicuous or absent, spreading radially, transverse-linear or obdeltoid, to 0.4 mm long, 0.3–0.4 mm wide, pink or red, glabrous, margin shallowly to deeply lobed; bracteoles 0.5–0.9 mm long, free or adnate for up to 1/3 of their length to involucre, free portion entire and subulate or divided into few subulate segments, glabrous. **Staminate** flowers 3–10 per cyathium; pedicels *c*. 0.8 mm long; staminal filaments *c*. 0.1 mm long. **Pistillate flowers**: styles 0.3–0.4 mm long, spreading, smooth, glabrous, each scarcely bifid or bifid for *c*. 1/3 of their length, the apices terete. **Capsules** exerted from involucre on pedicel to 2 mm long, broad-elliptic in lateral view, 1.5–1.8 mm long, 1.6–1.9 mm across, shallowly 3-lobate with keels obtuse, smooth or minutely papillose, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1.1–1.3 mm long, 0.7–0.8 mm tangentially, 0.7–0.8 mm radially, tetraquetrous or tetragonous in cross section; dorsal faces planar or convex; ventral faces planar; all faces with 3–5 prominent rounded transverse or irregular ridges; exotesta thin, of even thickness, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta reddish brown. $n = 11$. **Figs 8, 26C.**

***Additional selected specimens examined*: Western Australia**. 1 km E [of] Durack River crossing, Home Valley – Gibb River Road, Mar 1991, *Thomson 3461* (NT); 19 km SE of East Wyndham on Kununurra Road, Jul 1974, *Carr 3224 & Beauglehole 47002* (NSW, PERTH); Bobby Creek, 20.3 km N of turn off to Beagle Bay on Cape Leveque – Broome Road, Apr 1988, *Kenneally 10638* (PERTH); One Arm Point, NE of airstrip, Mar 1996, *Carter BJC708* (BRI, PERTH); NE of airstrip One Arm Point, Apr 1993, *Carter 629* (PERTH); W of Dragon Tree Soak, Great Sandy Desert, Aug 1977, *George 14803* (BRI, PERTH); 80 Mile Beach, near Caravan Park, May 1991, *Thomson 3662* (DNA, NT). **Northern Territory.** Twin Falls, Mar 1982, *Dunlop 6219 & Taylor* (BRI); Mataranka, Elsey N.P., Feb 1994, *Egan 3199* (DNA); Keep River N.P., Apr 1991, *Evans 3760* (BRI); Station Hill, Gregory N.P., Feb 1986, *Wightman 2746 & Clark* (DNA); Gregory N.P., Jasper Creek, Apr 1996, *Booth 1561 & Woodward* (DNA); Limmen Bight River upper reaches, Jan 1989, *Thomson 2859* (DNA); 7 Mile Spring, Gallipoli Station, Jan 1989, *Latz 11226* (DNA). **Queensland.** Cook District: 60.5 km by road E of Croydon, Gregory River area, Jan 2005, *McDonald KRM3489* (BRI). Burke District: Westmoreland Station, just W of Hells Gate, 15 km SE of homestead, May 2005, *Booth 4292 & Thompson* (BRI); 28.5 km SSW of Hells Gate Roadhouse on turnoff Lagoons Station, Apr 2006, *Thompson WES274 & Edginton* (BRI); 54 km NW of Burketown on Escott Station, Apr 2007, *Thompson WES1392 & Wilson* (BRI); 9.1 km by road W of Gilbert River Road crossing towards Croydon, Jan 2005, *McDonald KRM2402* (BRI); Calton Hills Station, N of Mt Isa, May 2004, *Booth 3488 & Kelman* (BRI).

***Distribution and habitat*:** *Euphorbia hassallii* occurs across northern Australia from the Kimberley, WA, through the northern regions of the NT and extending to near Emerald in central Qld (**Map 20**). It grows in eucalypt open forest/woodland, *Acacia* shrubland or tussock grassland communities on sandy to clay soils on plateaux, rocky slopes or plains.

***Phenology*:** Flowers and fruits have been collected from December to July.

***Notes*:** *Euphorbia hassallii* is similar to *E. drummondii* but differs in having generally longer styles (0.3–0.4 mm long) that are bifid for up to a 1/3 of their length, with terete apices (versus 0.2–0.3 mm long, entire or scarcely bifid, with clavate apices for *E. drummondii*). It also differs in generally having longer gland appendages (when present) that are shallowly to deeply lobed (versus gland appendages always present, entire and less than 0.1 mm long for *E. drummondii*) and stems often with a sparse indumentum proximally (versus stems always glabrous for *E. drummondii*).

Euphorbia hassallii is a morphologically variable complex and with further collections and study may be subdivided into a number of taxa. One of the more recognisable variants occurs in the Kimberley, WA. This variant tends to have a prostrate habit, smaller leaves, capsules and seeds, and deeply lobed gland appendages. Representative specimens of this variant are: 15 km N [of] Kalumburu Mission, Apr 1991, *Thomson 3468* (DNA, NT, PERTH); Sir Graham Moore Island, Jul 1973, *Wilson 11252* (PERTH); Durack Range, 90 km WSW of Kununurra, Feb 1993, *Keighery 140 & Gibson* (PERTH); Old Pago Mission, 22 km NNE of Kalumburu, Jun 1990, *Edinger 732* (PERTH).

***Etymology*:** The species is named in honour of Dr David Hassall, botanist and landscape architect, whose studies on the Australian *Euphorbieae* (Hassall 1977) have been of assistance in understanding the complexity of *Euphorbia* in Australia.

21. *Euphorbia hirta L., *Sp. Pl.* 454. 1753; *Chamaesyce hirta* (L.) Millsp., *Publ. Field Columb. Mus., Bot. Ser.* 2: 303 (1909). **Type:** “Habitat in India” (lecto: LINN [*Herb. Linn. No. 630.7*] *n.v.* (image seen) (IDC microfiche 177. 320: II. 5), *fide* Wheeler (1939: 72)).

Euphorbia pilulifera f. *humifusa* Domin, *Biblioth. Bot.* 89(4): 312 (1927 ‘1926’). **Type:** Queensland. [North Kennedy District:] apud opp. Pentland, February 1910, *K.Domin s.n.* (holo: PR 528327).

Euphorbia pilulifera f. *rubromaculata* Domin, *Biblioth. Bot.* 89(4): 312 (1927 ‘1926’). **Type:** not designated.

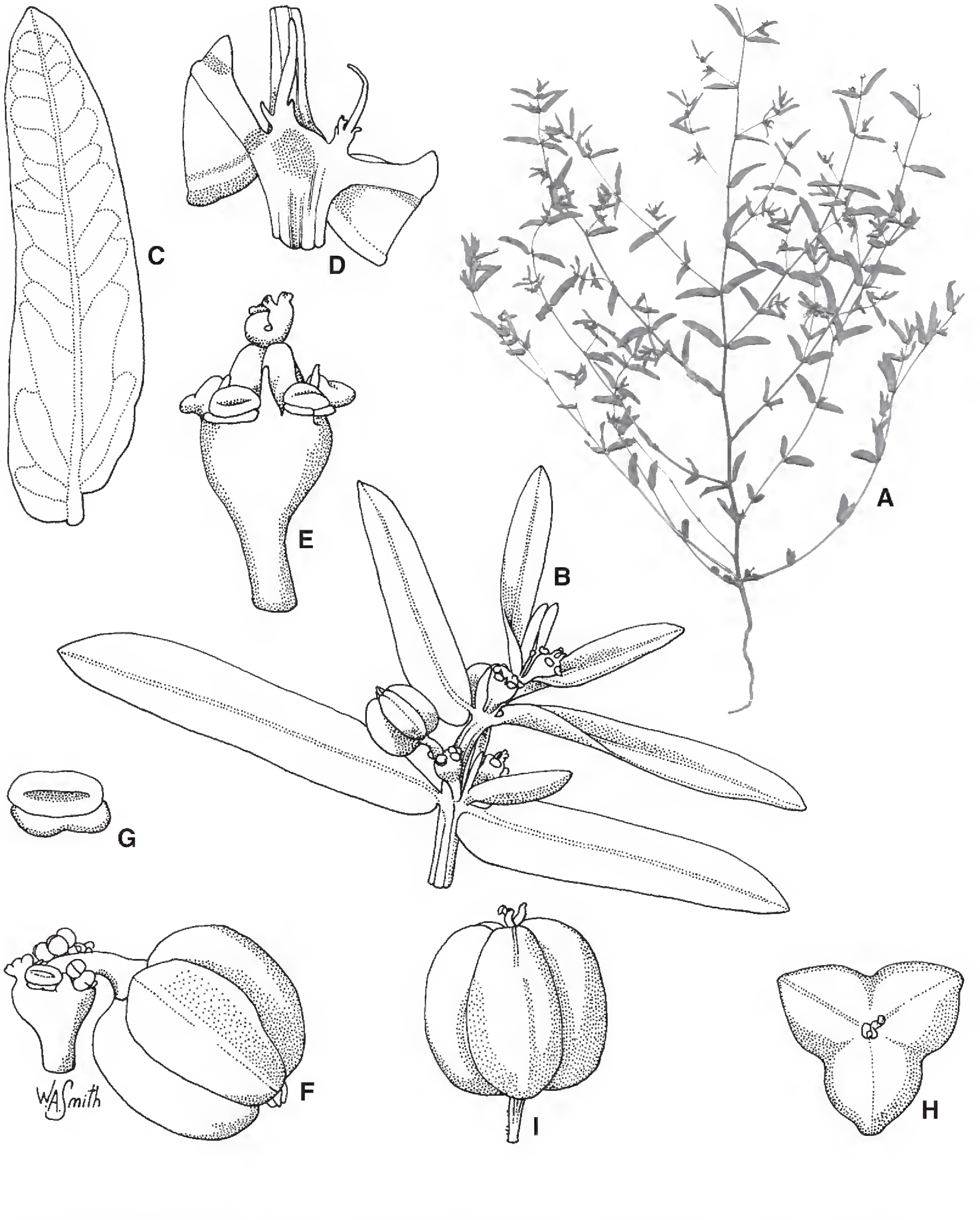

Fig. 8. ***Euphorbia hassallii.*** A. habit ×0.3. B. branchlet with cyathia ×4. C. leaf ×4. D. stipules ×16. E. cyathia with female flower ×24. F. capsule with cyathia ×12. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×12. I. capsule, lateral view ×12. A–I from *Barritt 1700* (BRI). Del. W.Smith.

Euphorbia pilulifera f. *viridis* Domin, *Biblioth. Bot.* 89(4): 312 (1927 '1926'). **Type:** not designated.

Euphorbia chrysochaeta W.Fitzg., *J. & Proc. Roy. Soc. Western Australia* 2: 162 (1918). **Type:** Western Australia. May River, nr. Emmanuel's Yards, May 1905, *W.V.Fitzgerald 436* (lecto [here designated]: PERTH *n.v.* (photo at BRI); isolecto: (NSW 612208).

***Illustrations*:** James & Harden (1990: 429), as *Chamaesyce hirta*; Lin *et al.* (1991: 229, fig. 8), as *Chamaesyce hirta*; Wheeler (1992: figs 183E, 184I, 185I, 186I); Aboriginal Communities of the Northern Territory (1993: 285–286); Dunlop *et al.* (1995: 218, fig. 72); Kleinschmidt *et al.* (1996: 31); Harris (2001: 32, fig. 1), as *Chamaesyce hirta*.

Monoecious, annual to 30 cm high, with one to a few stems arising from the base. Stems ascending to erect, sparingly branched, smooth, sparsely to densely hairy; indumentum consisting of white weakly appressed crispate hairs to 0.5 mm long interspersed with yellow spreading ± straight segmented hairs to 1.5 mm long. **Interpetiolar stipules** narrow-triangular, 1–1.8 mm long, bifid or deeply bipartite, sparsely hairy abaxially with white ascending hairs 0.2–0.3 mm long; margin laciniate. **Leaves**: petiole 0.5–3 mm long, smooth, with indumentum as for stems; blade ovate or elliptic, 10–50 mm long, 5–21 mm wide, 1.6–2 times longer than wide; adaxial surfaces red or dark green with reddish tinge, smooth, with a sparse indumentum consisting of white ± appressed curved hairs 0.2–0.4 mm long; abaxial surface pale green often with reddish tinge, smooth, with a sparse to moderately dense indumentum consisting of white ± appressed crispate or curved hairs up to 1.1 mm long and scattered yellow ± straight segmented hairs up to 1.5 mm long; base asymmetric with on side rounded, the other cuneate; margin serrulate; apex acute. **Cyathia** in dense (7–160 cyathia) terminal and axillary capitate, cymose clusters to 15 mm in diameter on peduncles 2–17 mm long; bracts subulate to narrow-triangular, to 0.5 mm long; cyathial peduncles 0.2–1.5 mm long. **Involucres** turbinate, 0.5–0.9 mm long, 0.5–0.7 mm across; lobes 5, triangular, 0.2–0.3 mm long, margin laciniate; glands 4, stipitate, cupuliform, concave or with shallow central pit, orbicular in outlline, 0.1–0.2 mm long, 0.1–0.2 mm wide, red or purple; gland appendages present and inconspicuous or absent, spreading radially, transverse-oblong or lunate, to 0.15 mm long, 0.1–0.3 mm wide, pink to white, glabrous, margin entire; bracteoles 0.4–0.5 mm long, adnate for *c.* 2/3 of their length to involucre, free portion divided into ± linear hairy segments. **Staminate flowers** 4–8 per cyathium; pedicels 0.3–0.8 mm long; staminal filaments 0.1–0.3 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, spreading, smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices clavate. **Capsules** exserted from involucre on pedicel to 1.2 mm long, depressed ovate in lateral view, 1–1.4 mm long, 0.9–1.4 mm across, shallowly 3-lobate with keels acute, smooth, pubescent; hairs appressed, *c.* 0.1 mm long; hypogynous disc entire. **Seeds** ovate in outline, 0.7–1 mm long, 0.4–0.5 mm tangentially, 0.4–0.5 mm radially, tetraquetrous in cross section; dorsal and ventral faces planar to concave, with 2–4 faint acute transverse ridges; exotesta very thin, of even thickness, grey-white, microreticulate or micropapillate, becoming mucilaginous when moistened; endotesta pale brown or red-brown. $n = 9$. **Fig. 26D.**

***Additional selected specimens examined*: Western Australia.** Kalumburu Mission, Apr 1991, *Willing 244* (PERTH); Kununurra, Mar 1978, *Aplin 6247* (PERTH); Chinatown, Broome, Aug 1985, *Kenneally 9390* (PERTH); Onslow, Feb 1985, *Dodd 173 & Madin* (PERTH); Carnarvon, Apr 1969, *Hawson s.n.* (PERTH 2846187). **Northern Territory.** Cobourg Peninsula; Black Point, Apr 1993, *Cowie 1535* (DNA, MEL); Nabarlek, Oct 1987, *Dunlop 7147* (DNA, MEL); Bullita Station, Gregory N.P., Feb 1992, *Cowie 2388 & Brocklehurst* (DNA); Borroloola townsite, Mar 1979, *Kalotas 239* (DNA); Docker River town, Mar 1980, *Henshall 2894* (DNA). **Queensland.** COOK DISTRICT: Unigan N.R., Weipa, Mar 1990, *Forster PIF6507 & O'Reilly* (BRI). BURKE DISTRICT: Warang homestead site, White Mountains N.P., 57 km by road N of Torrens Creek, Flinders River catchment, Apr 2000, *Thomas 1902 & Thompson* (BRI). LEICHHARDT DISTRICT: Springsure Creek, Springsure, Aug 2004, *Halford Q8318* (BRI). WIDE BAY DISTRICT: 1.5 km NNE of Didcot, Jan 1996, *Forster PIF18301* (BRI, MEL). MORETON DISTRICT: Emu Creek, Benarkin S.F., *c.* 11 km SE of Blackbutt, Feb 2003, *Halford Q7478* (BRI). **New South Wales.** Billinudgel, Middle Pocket Road, Lacks Creek, Apr 2003, *Forster PIF29321* (BRI); *c.* 2 miles [*c.* 3 km] NW of Coaldale, Jul 1969, *Clark 1848 et al.* (NSW); Grafton, Feb 1946, *Flintoff s.n.* (NSW 931); Whip Mountain, near Macksville, Mar 1981; *Ennis s.n.* (NSW 373094); 30 km from Singleton alongside the Putty Road, Mar 2001, *Hosking 2012* (MEL, NSW).

***Distribution and habitat*:** A native of the New World, now a common pantropical weed. In Australia, the species has become widespread across northern Australia from Carnarvon, WA through the NT to Qld south to Sydney, NSW (**Map 21**). It is a common weed of drainage lines, roadsides, lawns, garden beds and cultivated land.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from February to June.

***Notes*:** *Euphorbia hirta* is easily distinguished from the native Australian *Euphorbia* species by its indumentum of long yellowish coloured hairs on stems and petioles. *Euphorbia hirta* is very similar to *E. ophthalmica* Pers., but *E. hirta* has a more robust, erect habit with generally larger leaves and cyathia in axillary as well as terminal cymose glomerules.

22. *Euphorbia hyssopifolia L., *Syst. Nat.* 10th edn, 1048 (1759); *Chamaesyce hyssopifolia* (L.) Small, *Bull. New York Bot. Gard.* 3: 429 (1905). **Type:** Jamaica, *s.d.*, *P.Browne s.n.* (lecto: LINN [*Herb. Linn. No. 630.9*] *n.v.* (image seen) (IDC microfiche 177. 320: II. 7), *fide* Fawcett & Rendle [1920: 339]).

***Illustrations*:** Lin *et al.* (1991: 232, fig. 10), as *Chamaesyce hyssopifolia*; James & Harden (1990: 429), as *Chamaesyce nutans*; Carolin & Clarke (1991: 58), as *Euphorbia nutans*; Wilson *et al.* (1995: 109–110).

Monoecious, annual or sometimes herbaceous perennial with slender taproot, to 60 cm high, one or a few stems arising from rootstock. **Stems** ascending, erect (rarely prostrate), sparingly to much branched, smooth, glabrous or sparsely pubescent with hairs in two longitudinal bands; hairs to 0.4 mm long, weakly spreading, crispate, white. **Interpetiolar stipules** broad-triangular, 0.3–0.6 mm long, glabrous; margin lacerate with the teeth often gland-tipped. **Leaves**: petiole 0.5–2 mm long, smooth, glabrous or with indumentum as for stems; blade narrow-ovate or narrow-elliptic (rarely slightly falcate), 10–30 mm long, 4–11 mm wide, 2.5–5 times longer than wide; adaxial surface green sometimes with irregularly shaped reddish blotches or suffused with reddish tinge, smooth, glabrous or sparsely hairy with spreading, ± straight hairs to 1 mm long; abaxial surface pale green, smooth; glabrous or sparsely hairy with ascending, ± straight hairs to 1 mm long; base asymmetric with one side rounded to cordate, the other obtuse; margin serrulate; apex obtuse to rounded. **Cyathia** in lax 2–4 branched dichasial cymes together with a solitary cyathium at the distal nodes; peduncles 10–25 mm long; bracts leaf-like but smaller than primary stem leaves; cyathial peduncles 1–1.5 mm long. **Involucres** turbinate, 0.4–0.9 mm long, 0.8–1.2 mm across; lobes 5, triangular to subulate, 0.1–0.3 mm long, margin laciniate; glands 4, shortly stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, 0.1–0.4 mm long, 0.3–0.6 mm wide, pale green or pink; gland appendages present and conspicuous to inconspicuous, spreading radially, transverse-oblong, transverse-linear or reniform, 0.1–0.4 mm long, 0.3–0.6 mm wide, white or pink, margin entire; bracteoles 0.4–0.6 mm long, adnate for *c.* 2/3 of their length to involucre, free portion deeply divided into ± linear glabrous or hairy segments. **Staminate flowers** 5–12 per cyathium; pedicels *c.* 1 mm long; staminal filaments 0.1–0.4 mm long. **Pistillate flowers**: styles 0.2–0.4 mm long, erect to ascending, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2 mm long, depressed ovate or transversely broad-elliptic in lateral view, 1.5–2 mm long, 1.5–2 mm across, shallowly to deeply 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** broad-ovate in outline, 0.9–1.2 mm long, 0.5–0.9 mm tangentially, 0.7–0.8 mm radially, tetragonous in cross section; dorsal faces convex; ventral faces planar to convex; all faces with 2–4 prominent ± transverse acute ridges; exotesta thin, of even thickness over surface, grey-white, micropapillate, becoming mucilaginous when moistened; endotesta pale brown to dark brown. **Fig. 26E.**

***Additional selected specimens examined*:** **Western Australia.** Howatharra, SE of Northampton, 2001, Anon. (PERTH 6096956); Kitchener Street, Victoria Park, Perth, Apr 1997, *Lepschi 3410* (BRI, PERTH); Quarantine Office, Kewdale, Perth, Apr 2002, *Buckley s.n.* (BRI [AQ558138]). **Northern Territory.** Gove Golf Club, *Booth 2158* (DNA); Tennant Creek township, Nov 1996, *Latz 15020* (DNA); Undoolya Road, Alice Springs, Dec 1991, *Thomson 3573* (DNA). **Queensland.** BURKE DISTRICT: Normanton, Mar 1999, *Waterhouse BMW5136* (BRI). NORTH KENNEDY DISTRICT: Townsville Field Training Area (Dotswood sector), Camp McAliney (350 man camp), Apr 2001, *Waterhouse BMW6195* (BRI); 2 McPhenox Street, Charters Towers, Jan 1986, *Bolton 546* (BRI). LEICHHARDT DISTRICT: Charles Street, Springsure, Aug 2004, *Halford Q8314* (BRI); 57 km NW of Wandoan, Jan 2003, *Hodgkinson s.n.* (BRI [AQ732941]). PORT CURTIS DISTRICT: Heron Island, Oct 1998, *Batianoff 981087* (BRI). DARLING DOWNS DISTRICT: 2 km W of Macalister on road to Chinchilla, Feb 2004, *Halford Q8140 & Harris* (BRI). MORETON DISTRICT: Chapel Hill Reservoir, Fleming Road, *c.* 9 km W of Brisbane, Oct 1997, *Bean 12761* (BRI); Brocks Road, Currumbin Valley, Feb 2004, *Halford Q8160 & Edginton* (BRI). **New South Wales.** Clarrie Hall Dam, SW of Murwillumbah, Feb 2000, *Bean 16009* (BRI); Billinudgel, Middle Pocket Road, Lacks Creek, Apr 2003, *Forster PIF29322* (BRI); Byron Bay, Nov 1987, *Coveny 12780 et al.* (BRI); 30 km from Singleton alongside the Putty Road, Mar 2001, *Hosking 2013* (MEL, NSW); Wentworth Avenue, East Lakes, Jan 1984, *Coveny 11772 & Wilson* (NSW). **Australian Capital Territory.** Majura Avenue at junction with Officer Crescent, Dickson, Canberra, Feb 2006, *Lepschi 5432 & Mallinson* (BRI).

***Distribution and habitat*:** *Euphorbia hyssopifolia* is native to the tropic and subtropic regions of the Americas, now naturalised in tropical Africa, Asia and Australia. In Australia, the species is recorded in all mainland Australian States except Vic and SA (**Map 22**). The species frequently colonises sunny open positions, on sandy beaches, road verges, garden beds or disturbed ground.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia hyssopifolia* is recognised by having usually ascending to erect stems, broad-triangular interpetiolar stipules 0.3–0.6 mm long with lacerate margins and the teeth often gland-tipped, glabrous capsules and seeds surfaces with 2–4 prominent acute ± transverse ridges.

Collections from NSW here identified as *E. hyssopifolia* have been previously named *Chamaesyce nutans* (Lag.) Small (James & Harden 1990). *Euphorbia hyssopifolia* and *E. nutans* Lag. are native to North America and considered closely related. The main differences between the two species appear to be in seed sculpturing (seeds surfaces transversely ridged for *E. hyssopifolia* versus wrinkled for *E. nutans*), capsule size (1.5–2.1 mm long for *E. hyssopifolia* versus 1.9–2.3 mm long for *E. nutans*) (Burch 1966; Elmore & McDaniel 1986).

23. Euphorbia inappendiculata Domin, *Biblioth. Bot.* 89(4): 309 (1927 '1926'); *Chamaesyce inappendiculata* (Domin) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Western Australia.] between the Ashurton and the De Gray Rivers, *s.d.*, *E.Clement s.n.* (lecto [here designated]: PR 528295; isolecto: PR 528293).

Monoecious, annual or herbaceous perennial to 30 cm high, few to many stems arising from slender or thickened woody taproot. **Stems** prostrate, decumbent or ascending to erect, sparingly to much branched, glabrous or sparsely pilose with spreading, straight or curved white hairs 0.5–0.9 mm long, smooth. **Interpetiolar stipules** subulate, 1–1.8 mm long, bipartite, glabrous; margin entire, laciniate or irregularly toothed distally. **Leaves**: petiole 0.3–8 mm long, smooth, glabrous; blade narrow-oblong to oblong, oblanceolate, obovate, oblong-obovate or elliptic, 3–14 mm long, 1.5–6.5 mm wide, 1.5–4(4.7) times longer than wide; both surfaces green sometimes suffused with red pigmentation, smooth or minutely papillose; adaxial surface glabrous; abaxial surface glabrous or sparsely hairy with spreading, straight to curved hairs to 0.8 mm long; base asymmetric with one side cordate or rounded, the other cuneate or obtuse; margin entire or sparingly minutely toothed distally; apex obtuse to rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.1–0.8 mm long, smooth, glabrous. **Involucres** turbinate, campanulate or cupuliform, 0.4–0.8 mm long, 0.5–0.7 mm across; lobes 5, triangular or subulate, 0.1–0.5

mm long, margin entire, laciniate or sparsely ciliate; glands 4, stipitate, patelliform, concave with tangential trough or cupuliform with shallow central pit and sometimes with thickened margin, transverse-oblong or ± orbicular in outline, 0.05–0.15 mm long, 0.1–0.2 mm wide, pink or red; appendages conspicuous or absent, spreading radially, transverse-linear, 0.07–0.3 mm long, 0.2–0.4 mm wide, white, glabrous, margin entire or shallowly lobed; bracteoles 0.4–0.6 mm long, adnate for *c.* 1/6 of their length to involucre, free portion entire or divided into a few subulate segments, glabrous. **Staminate flowers** 3–5 per cyathium; pedicels 0.6–1 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.2–0.5 mm long, spreading to ascending, smooth, glabrous, each bifid for 1/3–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 1.5 mm long, elliptic to transversely broad-elliptic (rarely very broad-ovate) in lateral view, 1.3–1.6 mm long, 1.2–1.8 mm across, shallowly 3-lobate with keels acute or obtuse, smooth or minutely papillose (visible at 40× mag.), glabrous; hypogynous disc entire. **Seeds** ovate in outline, 0.9–1.3 mm long, 0.5–0.8 mm tangentially, 0.5–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar, concave or convex; ventral faces planar or concave; all surfaces smooth or with faint narrow rounded irregular or transverse ridges; exotesta thin, of even thickness over surface, white or grey-white, microreticulate, non mucilaginous or becoming mucilaginous when moistened; endotesta pale brown to brown.

***Distribution and habitat*:** *Euphorbia inappendiculata* is widespread in arid Australia from the Pilbara, WA through central NT to north-eastern SA and into central Qld and western NSW.

***Notes*:** *Euphorbia inappendiculata* is similar to *E. drummondii* but differs in having longer subulate stipules (1–1.8 mm long versus 0.5–0.9 mm long for *E. drummondii*), generally smaller glands, 0.1–0.15 × 0.1–0.2 mm (versus 0.15–0.2 × 0.2–0.4 mm for *E. drummondii*) that are patelliform, and planar to shallowly concave (versus glands cupuliform, with a distinct central pit and thickened rim for *E. drummondii*), and seeds surfaces smooth or with faint narrow rounded irregular or transverse ridges (versus seeds surfaces with 3–6 distinct transverse ridges for *E. drummondii*).

Euphorbia inappendiculata exhibits some discontinous variation in indumentum and gland appendage characters with some geographical discontinuity. This variation is considered sufficient to warrant formal recognition of three varieties within this species which can be distinguished using the following key.

Key to varieties of *Euphorbia inappendiculata*

1 Stems pilose; surface of seeds ± smooth or faintly undulate; exotesta not becoming mucilaginous when moistened **23a. E. inappendiculata** var. **inappendiculata**
1. Stems glabrous; surface of seeds with faint narrow rounded irregular or transverse ridges; exotesta becoming mucilaginous when moistened **2**

2 Gland appendages <0.1 mm long or absent; seeds 1.1–1.3 mm long; leaf blades 7–9 × 2.2–4 mm . . . . **23b. E. inappendiculata** var. **queenslandica**
2. Gland appendages 0.1–0.3 mm long; seeds 1–1.1 mm long; leaf blades 6–13 × 3.2–6.2 mm . . . . **23c. E. inappendiculata** var. **robustior**

23a. Euphorbia inappendiculata var. inappendiculata

Annuals or herbaceous perennials. **Stems** prostrate, sparsely pilose with spreading, straight or curved white hairs 0.5–0.9 mm long. **Leaves**: petiole 0.3–0.7 mm long; blade oblong, elliptic or oblong-obovate, 3–9 mm long, 1.5–5 mm wide, 1.5–2 times longer than wide; adaxial surface glabrous; abaxial surface glabrous, or with sparse spreading trichomes that are straight to curved, to 0.8 mm long, **Involucres** campanulate or cupuliform, 0.7–0.8 mm long, 0.5–0.6 mm across; glands, patelliform, concave with tangential trough, transverse-oblong in outline, *c.* 0.15 mm long, 0.1–0.2 mm wide; appendages transverse-linear, <0.1 mm long or absent. **Seeds** 0.9–1.1 mm long, 0.5–0.6 mm tangentially, 0.5–0.6 mm radially, tetraquetrous in cross section; facets smooth or faintly undulate. **Fig. 26F.**

***Additional selected specimens examined*: Western Australia.** 10 km W [of] Fortesque River bridge, Panawonica Railway, May 1991, *Thomson 3503* (NT, PERTH); 5 km N [of] Fortesque River crossing, Panawonica/Millstream Road, May 1991, *Thomson 3505* (NT); Two Mile Creek, Warralong Station, May 1941, *Burbidge 762* (PERTH); Barlee Range N.R., 10.8 km W of Mt Palgrave, 7.8 km NE of Mt Maitland, 11.3 km ESE of Mt Padbury, Barlee Range, Aug 1993, *van Leeuwen 1437* (PERTH).

***Distribution and habitat*:** *Euphorbia inappendiculata* var. *inappendiculata* is restricted to the Pilbara, WA, occurring from Barlee Range to Warralong Station (**Map 23a**). It is recorded as growing on heavy clay soils on open plains or gentle slopes.

***Phenology*:** Flowers and fruits have been collected in May and August.

***Typification*:** Domin (1927) based his description of *E. inappendiculata* on material collected by Clement from “Nordwest-Australien: zwischen Ashburton – und De Gray River”. Two sheets of a collection made by Clement from between the Ashurton and the De Gray Rivers, WA have been located amongst material on loan to BRI from PR and are numbered PR 528295 and PR 528293 respectively. The sheet PR 528295 is here selected as lectotype of *E. inappendiculata* because it is part of the original material, has morphology that matches the description in the protologue, and is the best preserved and more ample of the two specimens.

23b. Euphorbia inappendiculata var. queenslandica Domin, *Biblioth. Bot.* 89(4): 309 (1927 ‘1926’). Type: Queensland. [BURKE DISTRICT:] apud opp. Hughenden et Cloncurry, February 1910, *K.Domin s.n.* (holo: PR 528294).

Chamaesyce sp. B.; James & Harden (1990: 428).

Euphorbia “Marree” (F.J. Badman 776); Barker (1993: 50).

Chamaesyce sp. Marree (F.J.Badman 776); Barker (2005: 84).

Annuals to 15 cm high, whole plant glabrous. **Stems** prostrate, decumbent or ascending to erect. **Leaves**: petiole 0.3–0.6 mm long; blade narrow-oblong, oblanceolate or obovate, 7–9(14) mm long, 2.2–4 mm wide, 2.2–4(4.7) times longer than wide; adaxial and abaxial surfaces glabrous. **Involucres** turbinate, 0.5–0.6 mm long, 0.5–0.6 mm across; glands cupuliform, often poorly formed with shallow central pit and sometimes with thickened margin, ± orbicular in outline, to 0.1 mm long, 0.1–0.2 mm wide; appendages transverse-linear, <0.1 mm long or absent. **Seeds** 1.1–1.3 mm long, 0.5–0.7 mm tangentially, 0.5–0.7 mm radially, tetraquetrous in cross section; facets with faint narrow rounded irregular ridges. $n = 11$. **Figs 9, 26G.**

***Additional selected specimens examined*: Western Australia.** Calico Creek, 25 km W of Nicholson Station, May 1973, *Aplin 5326* (PERTH); 1.1 km S of Mt Brockman, 22 km W of Hamersley Station homestead, Sep 2006, *Halford Q9262* (BRI). **Northern Territory.** Victoria River Crossing, between Top Springs & Timber Creek, Jul 1974, *Carr 2751 & Beauglehole 46530* (MEL, NSW); Boree Creek, 6 m[iles] [*c.* 10 km] N [of] No. 48 bore, Brunette Downs, Apr 1970, *Latz 576* (AD, DNA); 24 km SW [of] Delmore Downs homestead, Jul 2000, *Albrecht 9255* (NT); 5 km SW [of] Alcoota Station homestead, Jul 2000, *Albrecht 9209 & Latz* (NT); Alice Springs Shooting complex claypan (Conlans Lagoon), Feb 2007, *Albrecht 12101 & Duguid* (BRI); 15 km N [of] Mt Dare homestead, Andado Station, Apr 1997, *Latz 15192* (DNA, NT). **Queensland.** BURKE DISTRICT: ‘Lydia Downs’ *c.* 45 miles [*c.* 72 km] NW of Maxwelton, Jan 1966, *Pedley 1958* (BRI). MITCHELL DISTRICT: 36.9 km SE of Winton on Longreach Road, Sep 1984, *Chinnock 6109* (AD); *c.* 55 miles [*c.* 88 km] NW of Longreach, Jul 1974, *Hassall 7438* (BRI). GREGORY NORTH DISTRICT:

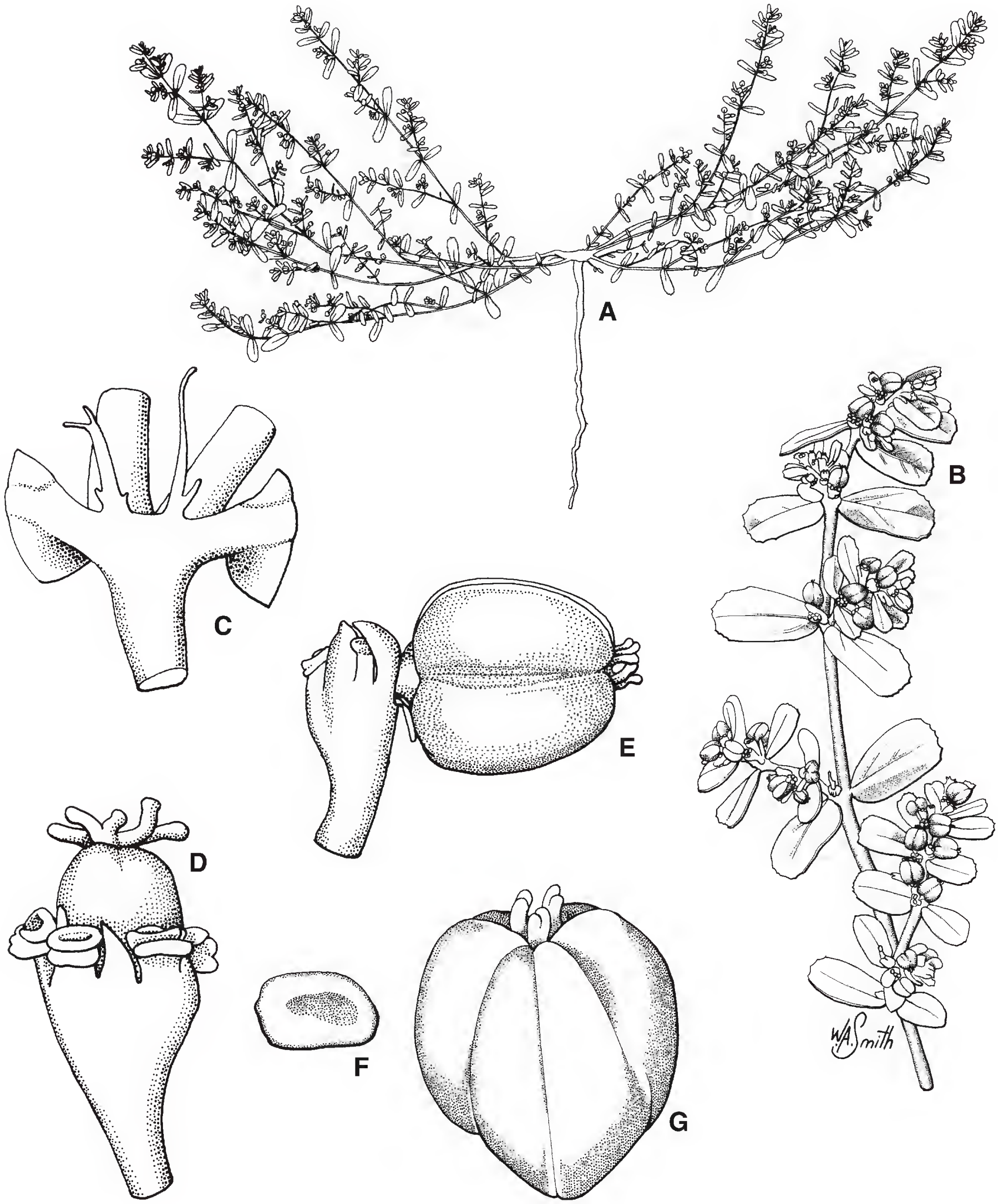

Fig. 9. ***Euphorbia inappendiculata*** var. ***queenslandica***. A. habit ×0.5. B. branchlet with cyathia ×2. C. stipules ×16. D. cyathia with female flower ×32. E. capsule with cyathia ×16. F. cyathial gland, adaxial view ×48. G. capsule, oblique view ×24. All from Halford 8128 (BRI). Del. W.Smith.

Long Hole, Winton Water Supply, Mar 1998, *Forster PIF22313 & Booth* (BRI). Warrego District: 14 km E of Cunnamulla on road to St George, Feb 2004, *Halford Q8128 & Harris* (BRI). **South Australia.** Site 4W, Coongie Lakes Survey, Feb 1988, *Gillen 1211* (AD); Peake Creek, on the William Creek – Oodnadatta Road, Feb 1983, *Weber 8947* (AD); Frome Downs Station, Apr 1968, *Barker 444* (AD). **New South Wales.** Walkdens Plain, Bourke, Mar 1974, *Milthorpe & 2179 Cunningham* (NSW); 'Glen Hope', Ingleby paddock, *c.* 10 km N of White Cliffs, Apr 1976, *Lawrie 1893* (NSW); 16 km S of Bourke on edge of Cobar Road, Mar 1973, *Keane 6* (NSW); Fowlers Gap Research Station, Broken Hill, Mar 1968, *Young MCB15023* (NSW); Pooncarie site Poo031, 4 km S of 'Melton Grove' on the Darnick Road (just N of Willandra Creek), May 1994, *Porteners 9405015 & Benson* (NSW).

***Distribution and habitat*:** *Euphorbia inappendiculata* var. *queenslandica* is widespread in arid and semi-arid eastern Australia, extending from central NT and north-eastern SA into central Qld and western NSW, with disjunct occurrences in the Hamersley Range and near the Nicholson River, WA, and Victoria River, north-western NT (**Map 23b**). It grows in *Astrebla* spp. grassland, *Acacia cambagei* low woodland, or grassland/chenopod shrubland communities on cracking clay soils on plains or gently undulating terrain.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia inappendiculata* var. *queenslandica* differs from *E. inappendiculata* var. *inappendiculata* in having glabrous stems, seed surface with faint narrow rounded irregular ridges, and exotesta that becomes mucilaginous when moistened. For features distinguishing *E. inappendiculata* var. *queenslandica* from *E. inappendiculata* var. *robustior*, refer to the 'Notes' section under that variety.

23c. Euphorbia inappendiculata var. **robustior** Halford & W.K.Harris, **varietas nova** a varietatis aliis *E. inappendiculatae* Domin plerumque caulibus robustioribus appendicibus glandulae majoribus 0.1–0.3 mm longis (ad vicem <0.1 mm in *E. inappendiculata* var. *inappendiculata* et var. *queenslandica* Domin) necnon ab *E. inappendiculata* var. *inappendiculata* caulibus glabris necnon *E. inappendiculata* var. *queenslandica* seminibus brevioribus 1–1.1 mm longis (ad vicem 1.1–1.3 mm longis) differt. **Typus:** Northern Territory. 6 miles [*c.* 10 km] east [of] No. 7 bore near Elliott, 19 February 1969, *P.K.Latz 435* (holo: DNA, iso: BRI; according to label information on the holotype sheet there are duplicates (isotypes) lodged at K *n.v.*, MO *n.v.*).

Annuals or herbaceous perennials to 30 cm high, whole plant glabrous. **Stems** mostly prostrate or rarely ascending. **Leaves**: petiole 0.8–2 mm long; blade oblong, obovate, or oblong-obovate, 6–13.2 mm long, 3.2–6.2 mm wide; 1.8–3 times longer than wide; adaxial and abaxial surfaces glabrous. **Involucres** turbinate, 0.4–0.7 mm long, 0.5–0.7 mm across; glands cupuliform, often poorly formed, concave, orbicular in outline, to 0.1 mm long, 0.1–0.2 mm wide; appendages oblong, 0.1–0.3 mm long, 0.2–0.4 mm wide. **Seeds** 1–1.1 mm long, 0.6–0.8 mm tangentially, 0.6–0.8 mm radially, tetraquetrous or tetragonous in cross section; facets with faint narrow rounded irregular or transverse ridges. **Fig. 26H.**

***Additional selected specimens examined*:** **Northern Territory.** Stuart Highway at Newcastle Creek, Mar 1979, *Kalotas 225* (DNA); 7 km E of No. 7 Bore, Newcastle Waters Station, Mar 1979, *Kalotas 208*, *210* (DNA); 36 km SW [of] Ucharonidge homestead, Feb 1989, *Thomson 3235* (DNA); 5 km SW [of] No. 9 Bore, Brunchilly Station, Jun 1984, *Low 127* (DNA); 30 miles [*c.* 48 km] NW of Rockhampton Downs Station, Jul 1948, *Perry 1588* (DNA); Alexandria Station, 15 km NW of homestead, Mar 1981, *Henshall 3519* (DNA); 10 km NNE of Connells Bore (Pictorella Swamp), May 1982, *Latz 9139* (DNA); Connells Lagoon, Sep 1986, *Piercey s.n.* (DNA [A0088677], NT 88677). **Queensland.** Burke District: *c.* 40 km NW of Burke and Wills Roadhouse along Wills Developmental Road (160 km SSE of Burketown), 1995, *Kemp 890 & Fairfax* (BRI); 25 km E of Richmond, May 1974, *Byrnes 3017* (BRI).

***Distribution and habitat*:** *Euphorbia inappendiculata* var. *robustior* occurs from Newcastle Waters, NT, east to Richmond, north-western Qld (**Map 23c**). It grows in mostly *Astrebla* spp. grassland or chenopod shrubland communities on clay loam to cracking clay soils on plains or floodouts.

***Phenology*:** Flowers and fruits have been collected from February to September.

Notes: *Euphorbia inappendiculata* var. *robustior* differs from the other varieties of *E. inappendiculata* by its generally more robust stems and larger gland appendages (0.1–0.3 mm long versus <0.1 mm long for *E. inappendiculata* var. *inappendiculata* and *E. inappendiculata* var. *queenslandica*). It also differs from *E. inappendiculata* var. *inappendiculata* in having glabrous stems). It differs from *E. inappendiculata* var. *queenslandica* in having shorter seeds (1–1.1 mm long versus 1.1–1.3 mm long for *E. inappendiculata* var. *queenslandica*).

Etymology: The varietal epithet is from Latin *robustus*, robust, and the comparative suffix; *–ior* more so, to a greater degree, in reference to the more robust habit of this variety when compared with the other varieties of this species.

24. Euphorbia kimberleyensis B.G.Thomson, *Nuytsia* 8: 358, fig. 4 (1992). **Type:** Western Australia. Palm Woodland, Mitchell Plateau, West Kimberley, 15 June 1976, *K.F.Kenneally 4921* (holo: PERTH; iso: CANB *n.v.*, *fide* Thomson [1992: 358]).

Illustrations: Wheeler (1992: figs 184Q, 185Q, 186Q), as *Euphorbia* sp. A; Thomson (1992: 359, fig. 4).

Monoecious, annual to 20 cm high, few to many stems arising from fibrous roots. **Stems** mostly prostrate or occasionally decumbent to ascending, much branched, moderately densely hairy on one side, smooth; hairs ascending-spreading, curved (retrorse) or occasionally straight, to 1 mm long, white. **Interpetiolar stipules** subulate to triangular, 0.8–1.9 mm long, entire or bipartite, glabrous; margin ± entire or laciniate. **Leaves**: petiole 0.6–2 mm long, smooth, glabrous; blade ovate to broad-ovate, occasionally slightly falcate, 9–27 mm long, 6–16 mm wide, 1.2–1.8 times longer than wide; adaxial surface green developing purplish tinge with age; abaxial surface pale green; both surfaces smooth, glabrous; base asymmetric with one side cordate, the other obtuse to rounded; margin entire or sparingly minutely toothed; apex obtuse to rounded sometimes with short acuminate or apiculate tip. **Cyathia** solitary at the nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 1–4 mm long, smooth, glabrous. **Involucres** turbinate, 1.5–2 mm long, 1.5–2.5 mm across; lobes 5, triangular, 0.6–1.1 mm long, margin entire; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, 0.5–0.7 mm long, 0.8–1.5 mm wide, red; gland appendages conspicuous, spreading radially, ± obdeltoid, (0.5)1.3–2.5 mm long, 1.2–2.5 mm wide, pink to white, glabrous, margin dentate to laciniate; bracteoles 1.4–1.9 mm long, adnate for *c.* 1/2 of their length to involucre, free portion divided into numerous subulate plumose segments. **Staminate flowers** 19–32 per cyathium; pedicels 1.9–2.1 mm long; staminal filaments 0.4–0.8 mm long. **Pistillate flowers**: styles 0.7–1.5 mm long, erect with spreading apices, smooth, glabrous, entire, the apices terete. **Capsules** exserted from involucre on pedicel to 5 mm long, broad to very broad-ovate or broad-elliptic in lateral view, 3.5–4 mm long, 3.8–4 mm across, shallowly 3-lobate with keels acute, papillose, glabrous or rarely sparsely hairy with hairs confined to keels, spreading, to 1.5 mm long; hypogynous disc entire. **Seeds** ovate in outline, 2–2.8 mm long, 1.5–1.8 mm tangentially, 1.5–1.8 mm radially, tetraquetrous in cross section; dorsal faces ± planar; ventral faces planar or slightly concave; all surfaces with low rounded irregular ridges; exotesta of uneven thickness over surface, distinctly thicker on the ridges, pale brown, microreticulate, becoming mucilaginous when moistened; endotesta dark brown. **Fig. 26I.**

Additional selected specimens examined: **Western Australia.** Port Warrender area, Apr 1988, *Dunlop 7881* (DNA); area of Carson Volcanics towards Port Warrender off the laterite plateau, May 1978, *Kenneally 6704* (PERTH); eastern margin of Mitchell Plateau, Apr 1991, *Willing 326* (PERTH); near Lone Dingo VT, 9 km SW of Warrender Hill, Jun 1987, *Alford 551* (PERTH); 5 km N [of] Theda homestead, Apr 1991, *Thomson 3466* (AD); Kalumburu road, 108.9 km by road N of junction with Gibb River and Ellenbrae Road, Apr 1985, *Aplin 721 et al.* (PERTH); Silver Gull Creek at spring, *c.* 14 km SE of Cockatoo Island, Apr 1983, *Fryxell & Craven 3868* (PERTH); Gibbings Island, Buccaneer Archipelago, Jun 1982, *Kenneally 8443* (PERTH); Warren Arms fishing camp, Coppermine Creek, Buccaneer Archipeligo, Apr 1997, *Brockway CB136* (PERTH); Koolan Island, Jun 1985, *Fryxell 4582 et al.* (PERTH); garden behind house, Warren Arms Camp, Apr 1992, *Mitchell 2252*

(PERTH); Crocodile Creek, 5 km E of W end of Koolan Island, May 1986, *Kenneally 9719* (PERTH); Milliwindi track opposite Bold Bluff, Apr 1988, *Cranfield 6382* (PERTH); 5 km N [of] King Leopold Ranges, Apr 1991, *Thomson 3469* (AD, BRI).

Distribution and habitat: *Euphorbia kimberleyensis* is restricted to the Kimberley, WA, occurring from the Buccaneer Archipelago, east to the King Leopold Range and north east to the Port Warrender and near Kalumburu (**Map 24**). It grows in eucalypt open woodland or *Triodia* grassland communities in rocky sites along creeklines or on hillsides. The soils are recorded as loam or red clay. The geological substrate may be sandstone, laterite or basalt.

Phenology: Flowers and fruits have been collected from April to June.

Notes: *Euphorbia kimberleyensis* seems most closely related to *E. schizolepis*. It differs by its glabrous leaves, cyathia and gland appendages, stems glabrous or with longitudinal bands of hairs, capsules glabrous or rarely with a few hairs along the keels (versus leaves, cyathia, gland appendages, capsules and stems densely hairy for *E. schizolepis*) and fewer staminate flowers per cyathium (15–25 per cyathium versus 30–40 per cyathium for *E. schizoplepis*).

25. Euphorbia laciniloba Halford & W.K.Harris, **species nova** similis *E. petalae* Ewart & L.R.Kerr et *E. ophioliticae* (P.I.Forst.) Y.Yang sed ab *E. petala* stylis 1/3–1/2 longitudinis bifidis (ad vicem stylis integris vel vix bifidis), appendicibus glandulae profunde laciniatis lobis acutis usque attenuatis (ad vicem dentatis vel breviter lobatis rotundatis obtusisve), crescentibus plerumque in solo argillaceo (ad vicem crescentibus in solo arenario necnon seminibus minoribus 1.1–1.6 × 0.7–1 x 0.7–1 mm (ad vicem seminibus 1.7–1.8 x 1–1.1 x 1–1.1 mm), foliis oblongis usque oblongo-ellipticis vel ovatis 1.6–2.8 plo longioribus quam latioribus (ad vicem ellipticis usque lato-ellipticis 1–1.5 plo longioribus quam latioribus) differt. **Typus:** Queensland. Port Curtis District: Marlborough Creek crossing, 3.4 km W of Marlborough on road to Sarina, 28 November 2004, *D.Halford Q8783 & G.Batianoff* (holo: BRI, iso: MICH).

Monoecious, herbaceous perennial to 10 cm high, many annual stems arising from woody taproot. **Stems** prostrate or weakly ascending, much branched, longitudinally ridged, glabrous or rarely sparsely hairy; hairs spreading, straight to 0.15 mm long, white. **Interpetiolar stipules** narrowly to broadly triangular, 0.2–0.9 mm long, entire or deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.4–0.9 mm long, smooth, glabrous; blade oblong or oblong-elliptic, 4.3–10.5 mm long, 2.2–5 mm wide, 1.6–2.2 times longer than wide; both surfaces minutely papillose (visible at 40× mag.), glabrous; adaxial surface mainly blue-green with red along the margins; abaxial surface similar to but paler than adaxial surface; base asymmetric with one side shallowly cordate, the other cuneate or obtuse; margin serrulate; apex rounded. **Cyathia** solitary at the nodes; peduncles 1.3–2 mm long, smooth, glabrous, or with a few isolated hairs to 0.1 mm long. **Involucres** campanulate, 0.8–1.1 mm long, 0.8–1.5 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin fimbriate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, 0.2–0.4 mm long, 0.5–1 mm wide, yellowish green or red; gland appendages conspicuous, spreading radially, obdeltoid or oblong, 0.4–1 mm long, 0.8–1.5 mm wide, white or pink, glabrous, margin laciniate; bracteoles 0.7–1 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into numerous subulate hirsute segments. **Staminate flowers** (5)10–17 per cyathium; pedicels 1–1.2 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, spreading, smooth, glabrous, each bifid for1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, depressed ovate in lateral view, 1.6–1.7 mm long, 2–2.1 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, (0.9)1.1–1.4 mm long, (0.7)0.8–0.9 mm tangentially, 0.7–0.9 mm radially, tetraquetrous or tetragonous in cross section; dorsal faces planar or convex; ventral faces planar or concave; all surfaces with faint narrow rounded transverse or irregular ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta brown. **Figs 10, 26J.**

***Additional selected specimens examined*: Queensland.** LEICHHARDT DISTRICT: 35 km NE of Capella, Mar 1995, *Fensham 2784* (BRI); Warren State Farm, Mar 1920, *Francis s.n.* (BRI [AQ202944]); 35 km SE of Springsure, Jan 1996, *Fensham 2387* (BRI); Palmgrove N.P., NW of Taroom, Bigge Range, Nov 1998, *Forster PIF23707 & Booth* (BRI). PORT CURTIS DISTRICT: Marlborough area, Gap Creek Road, Spring Creek, Oct 2001, *Batianoff 01102GNB et al.* (BRI); near Koolkoorum Creek, S.F. 121, Dawes Range, Feb 1994, *Thompson CAL150 et al.* (BRI). BURNETT DISTRICT: Kingaroy, Apr 1947, *Smith 3051* (BRI). MARANOA DISTRICT: N of Mt Rugged, Mt Moffatt N.P., Dec 1997, *Bean 12876* (BRI).

***Distribution and habitat*:** *Euphorbia laciniloba* is restricted to central-east and south-east Qld, from Marlbrough south to the Bunya Mountains and west to the Carnarvon Range (**Map 25**). It grows in eucalypt woodland or *Poa* grassland communities on alluvial flats, hills or plains. The soils are loam to clays, rarely sand, mostly derived from basalt substrates, rarely from sandstone or mudstone.

***Phenology*:** Flowers and fruits have been collected from October to July.

***Notes*:** *Euphorbia laciniloba* is similar to *E. petala* and *E. ophiolitica* (P.I.Forst.) Y.Yang. It differs from *E. petala* by having styles bifid 1/3 to 1/2 of their length (versus styles entire or scarcely bifid for *E. petala*), gland appendages deeply laciniate with acute to attenuate lobes (versus toothed or shallowly lobed with lobes rounded or obtuse at tip for *E. petala*), capsules only slightly broader at the base (versus distinctly broader at the base for *E. petala*) and growing on mostly clay soils (versus growing on sandy soils for *E. petala*). It differs from *E. ophiolitica* by having smaller seeds, 1.1–1.6 × 0.7–1 × 0.7–1 mm (versus 1.7–1.8 × 1–1.1 × 1–1.1 mm for *E. ophiolitica*) and leaf blades oblong to oblong-elliptic or ovate, 1.6–2.8 times as long as wide (versus elliptic to broad elliptic, 1–1.5 times long as wide for *E. ophiolitica*).

***Etymology*:** The specific epithet is from Latin *laciniatus*, slashed into narrow divisions with tapered-pointed incisions, and *lobus*, lobe, in reference to the divided gland appendages of this species.

26. Euphorbia litticola Halford & W.K.Harris, **species nova** quoad habitationem litoralem foliorum crassitudinem, cyathiorum dispositionem, seminum formam, amplitudinem sculturamque similis *E. pallenti* Dillwyn sed habitu robustiore caulibus crassioribus usque 5 mm diam. in internodiis (ad vicem caulibus usque 3.5 mm) stipulis chartaceis lato-ovatis 1.5–3 mm longis glabris superficiebus ambabus (ad vicem stipulis ± coriaceis triangularibus 1–1.5 mm longis pubescentibus in superficiebus adaxialibus) basibus foliorum symmetricis cordatisque usque auriculatis (ad vicem basibus asymmetricis hinc cordatis illinc obtusis usque leviter cordatis) differt. **Typus:** Northern Territory. Melville Island, 7 km NW of Point Elly, 28 November 1989, *P.I.Forster PIF6113 & R.Petherick* (holo: BRI; iso: MEL, according to label information on the holotype sheet there are duplicates (isotypes) lodged at CNS [formerly QRS] *n.v.* & DNA *n.v.*).

Euphorbia levis var. *imbricata* Boiss., in A.DC., *Prodr.* 15(2): 13 (1862). **Type:** [Northern Territory.] Port Essington, *s.d.*, [*J.W.*] *Armstrong s.n.* (holo: K).

***Illustrations*:** Wheeler (1992: figs 183A, 184A, 185A, 186A) as *Euphorbia atoto*; Dunlop *et al.* (1995: 218, fig. 72), as *Euphorbia atoto*.

Monoecious, herbaceous perennial to 70(150) cm high, many stems arising from woody rootstock, the whole plant glabrous. **Stems** decumbent to erect (rarely rhizomatous, *Dunlop 9793 & Wightman* [DNA]), much branched, smooth. **Interpetiolar stipules** broad-triangular, 2–3 mm long, chartaceous, reddish brown, entire or bifid at apex, glabrous; margin lacerate. **Leaves**: petiole 1–2 mm long, smooth; blade oblong, ovate or oblong-elliptic, 18–32 mm long, 8–16 mm wide, 1.8–2.5 times longer than wide; adaxial surface blue-green sometimes with reddish tinge, smooth or minutely papillose; abaxial surface similar to but paler than adaxial surface; base ± symmetric, auriculate to cordate; margin entire or serrulate; apex obtuse to rounded with short apiculate tip. **Cyathia** in congested 2 or 3 branched dichasial cymes together with a solitary cyathium at the distal nodes; peduncles 5–10

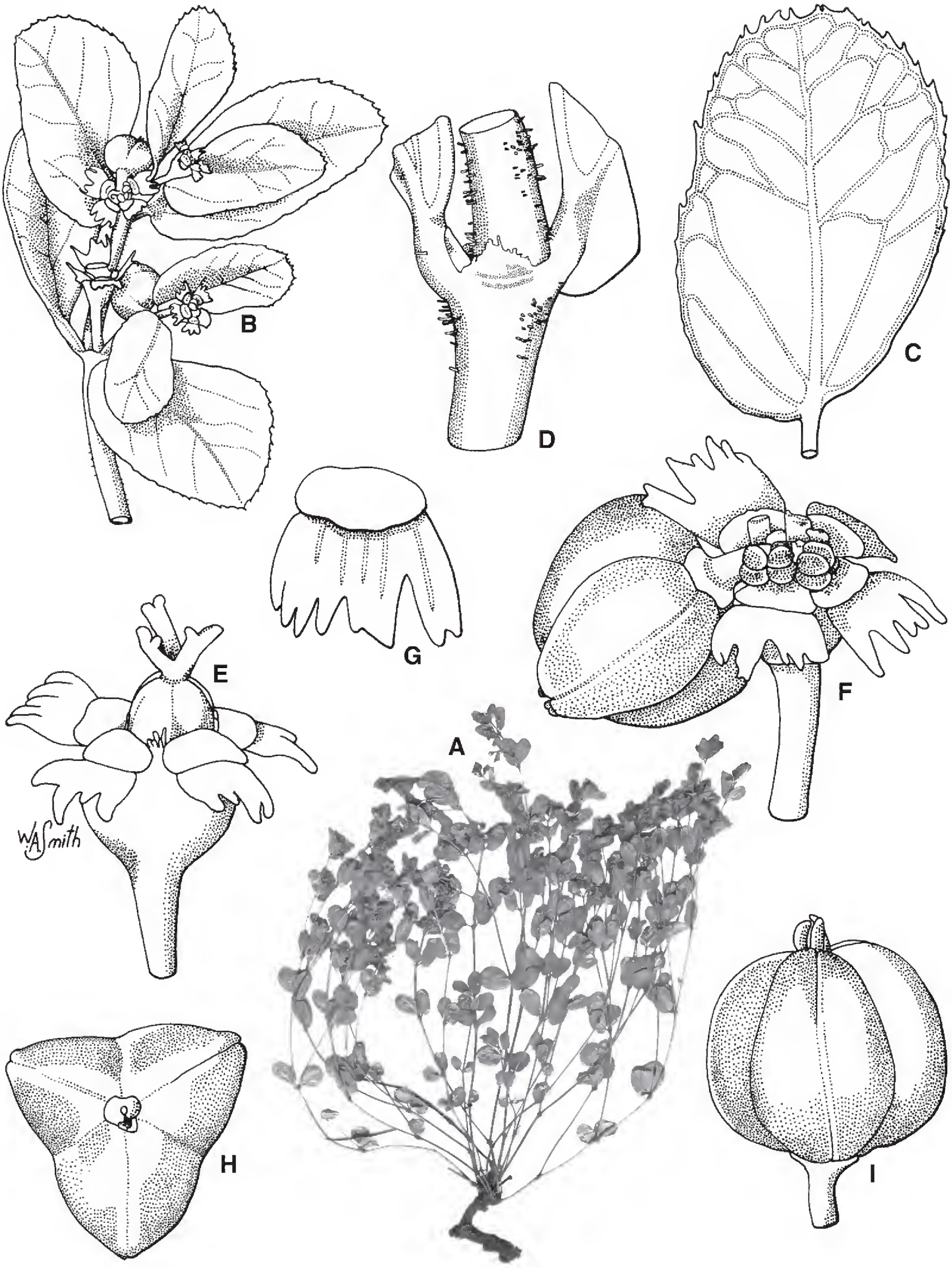

Fig. 10. ***Euphorbia laciniloba.*** A. habit ×0.6. B. branchlet with cyathia ×4. C. leaf ×6. D. stipules ×12. E. cyathia with female flower ×24. F. capsule with cyathia ×16. G. cyathial gland with appendage, adaxial view ×24. H. capsule, top view ×16. I. capsule, lateral view ×16. All from *Halford Q8793 & Batianoff* (BRI). Del. W.Smith.

mm long; bracts leaf-like but smaller than the primary stem leaves; cyathial peduncles 1–9 mm long. **Involucres** turbinate or cupuliform, 1.5–1.8 mm long, 1.6–1.8 mm across; lobes 5, triangular, 0.6–0.8 mm long, margin laciniate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-elliptic in outline, 0.4–0.5 mm long, 0.6–1 mm wide, green or yellowish green; gland appendages inconspicuous or absent, spreading radially, transverse-linear or lunate, 0.1–0.3 mm long, 0.9–1 mm wide, white, glabrous, margin entire or dentate; bracteoles 1.5–1.9 mm long, adnate for 1/2–2/3 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** *c.* 25 per cyathium; pedicels 1.5–2.2 mm long; staminal filaments 0.6–0.7 mm long. **Pistillate flowers**: styles 0.8–1 mm long, ascending, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 6 mm long, very broad-ovate in lateral view, 3–3.2 mm long, 3.7–4.2 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** very broad-elliptic in outline, 1.7–1.8 mm long, 1.4–1.6 mm tangentially, 1.5–1.7 mm radially, suborbicular in cross section, dorsal and ventral faces convex, smooth; exotesta thin, of even thickness over surface, chalky-white, microreticulate, not becoming mucilaginous when moistened; endotesta brown. **Figs 11, 26K.**

***Additional selected specimens examined*: Western Australia.** Cape Anjo, Jul 1973, *Wilson 11303* (PERTH); Wollaston Island, Jun 1972, *Marchant 72/316* (PERTH); Krait Bay, Cape Voltaire, Bonaparte Archipelago, May 1998, *Mitchell 5422* (BRI, PERTH); Vansittart Bay at E end of airstrip on Anjo Peninsula, Jun 1992, *Kenneally 11232* (DNA, PERTH). **Northern Territory.** New Year Island, Apr 1995, *Booth 518* (DNA); Melville Island, Penelli Beach, Jun 1992, *Cowie 2187 & Cowie* (DNA); Cobourg Peninsula, Trepang Bay, Apr 1993, *Cowie 3605* (DNA); Mountnorris Bay, foot of Cobourg Peninsula, *c.* 35 km W of Murgenella, Jun 1988, *Munir 6125* (AD, BRI); Black Point, Cobourg Peninsula, Oct 1968, *Byrnes NB1094 & Maconochie* (AD, DNA); Annesley Point, Malay Bay, Jun 1988, *Munir 6097* (AD, BRI); Grant Island, May 1992, *Dunlop 8983* (DNA); Murgenella, Malay Bay, Jul 1985, *Wightman 1971* (DNA); Arnhem Land, S side Anuru Bay, Oct 1992, *Cowie 3123* (DNA, MEL); Cotton Island, May 1992, *Cowie 2941* (DNA); English Company Islands, Truant Island, Jul 1992, *Leach 3038* (DNA); Wigram Island, Outstation, Aug 1995, *Cowie 6062* (DNA); Port Bradshaw, Sep 1993, *Dunlop 9793 & Wightman* (DNA). **Queensland.** COOK DISTRICT: Aurukun Reserve, 5 km S of Kirke River mouth, Oct 1978, *Smyth s.n.* (BRI [AQ412998]). BURKE DISTRICT: 10 km W of Massacre Inlet, Wentworth Station, Dec 1984, *Halford 841217* (DNA); Charlie Bush Bay, Mornington Island, Sep 1981, *Fosberg 62011* (BRI).

***Distribution and habitat*:** *Euphorbia litticola* occurs in coastal areas from Bonaparte Archipelago, Kimberley, WA, across the NT to Aurukun on the west coast of Cape York Peninsula, Qld (**Map 26**). It most likely extends into the Indonesian Archipelago. It grows on sandy coastal foreshores usually just above the strand line.

***Phenology*:** Flowers and fruits have been collected throughout the year, more frequently from April to July.

***Notes*:** *Euphorbia litticola* is similar to *E. pallens* Dillwyn in its coastal habitat, leaf thickness, cyathia arrangement and seed shape, size and sculpturing. It differs from *E. pallens* by its more robust habit with thicker stems (up to 5 mm diameter at internodes as compared with up to 3.5 mm diameter for *E. pallens*), stipules chartaceous, broad-ovate, 1.5–3 mm long and glabrous on both surfaces (versus stipules ± leathery, triangular, 1–1.5 mm long and pubescent on the adaxial surface for *E. pallens*) and leaf bases symmetrical cordate to auriculate (versus asymmetrical, with one side cordate, the other obtuse to shallowly cordate for *E. pallens*).

***Etymology*:** The specific epithet is from Latin *littus*, sea-shore, beach, and *-icola*, dweller or inhabitant, in reference to the where this species has been recorded growing.

27. Euphorbia macdonaldii Halford & W.K.Harris, **species nova** similis *E. australi* Boiss. sed stylis integris plerumque brevioribus 0.2–0.3 mm longis (ad vicem 0.3–0.6 mm longis bifidis 1/3–2/3 longitudinis) capsulis lato-usque per lato-ovatis aspectu laterali manifeste latioribus basim versus (ad vicem lato ellipticis aspectu laterali manifeste latioribus aequatorem versus) plerumque seminibus minoribus 0.7–0.9 × 0.5–0.6 × 0.5–0.7 mm (ad vicem seminibus 0.8–1.6 × 0.6–0.9 × 0.6–0.9 mm) differt. **Typus:** Queensland. COOK DISTRICT: 1 km S of Lappa on Mt Garnet road, 12 April 2005, *P.I.Forster PIF30732 & K.R.McDonald* (holo: BRI, iso: MEL, NSW, *distribuendi*).

Monoecious (rarely dioecious), herbaceous perennial to 15 cm high, few to many stems arising from woody taproot. **Stems** prostrate or ascending, much branched, smooth or sometimes longitudinally ridged, with a sparse to dense indumentum (rarely glabrous); hairs spreading, ± straight, 0.5–1.0 mm long, white. **Interpetiolar stipules** narrow-triangular to triangular, 0.2–0.7 mm long, bipartite, indumentum as for stems or glabrous; margin laciniate. **Leaves**: petiole 0.4–1.2 mm long, smooth, glabrous or with indumentum as for stems; blade oblong, oblong-elliptic, elliptic to broad-elliptic or oblong-obovate, 4–9.5 mm long, 2.5–7 mm wide, 1–1.9 times longer than wide; adaxial and abaxial surfaces red to pink or green with reddish tinge over surface or along margin, smooth (rarely papillose, *Henshall 379* [BRI]), glabrous or with a moderately dense indumentum; hairs spreading, straight, 0.1–0.3 mm long; base asymmetric with one side cordate to rounded, the other cuneate to rounded; margin serrulate to serrate or only toothed distally; apex rounded to retuse. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.4–0.6 mm long, smooth, glabrous. **Involucres** turbinate, 0.8–1.2 mm long, 0.7–1.3 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin entire; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong to transverse-elliptic in outline, 0.2–0.4 mm long, 0.3–0.6 mm wide, pink, cream to yellow; gland appendages inconspicuous, spreading radially, transverse-oblong to transverse-linear or lunate, 0.1–0.4 mm long, 0.5–0.8 mm wide, pink, glabrous, margin dentate, irregularly shallowly lobed or entire; bracteoles 0.1–0.8 mm long, divided into few to numerous subulate glabrous segments. **Staminate flowers** 5–15 per cyathium; pedicels 0.8–1.1 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, spreading to ascending, smooth, glabrous or pubescent abaxially, entire, the apices terete. **Capsules** exserted from involucre on pedicel to 2.5 mm long, broad to very broad-ovate in lateral view, 1.1–1.4 mm long, 1.3–1.6 mm across, shallowly 3-lobate with keels obtuse or acute, ± smooth or minutely papillose, glabrous or sparsely to densely hairy; hairs white spreading, 0.1–0.3 mm long; hypogynous disc entire. **Seeds** ovate in outline, 0.7–0.9 mm long, 0.5–0.6 mm tangentially, 0.5–0.6 mm radially, tetraquetrous in cross section; dorsal and ventral faces planar or concave, smooth or with faint transverse or irregular ridges; exotesta thin, of even thickness over surface, grey-white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown.

Distribution and habitat: *Euphorbia macdonaldii* occurs in north-eastern Qld, from near Chillagoe south to near Mt Coolon with a disjunct population in the Nicholson River area, NT.

Notes: *Euphorbia macdonaldii* is similar to *E. australis* but differs by having entire styles which are generally shorter (0.2–0.3 mm long versus styles 0.3–0.6 mm long and bifid for 1/3–2/3 of the length for *E. australis*), broad to very broad-ovate capsules in lateral view which are distinctly broader towards the base (versus broad-elliptic in lateral view and distinctly broader towards the equator for *E. australis*) and generally smaller seeds (0.7–0.9 × 0.5–0.6 × 0.5–0.7 mm versus 0.8–1.6 × 0.6–0.9 × 0.6–0.9 mm for *E. australis*).

As circumscribed here, this species exhibits discontinuty in density, distribution and length of the indumentum. Two varieties are here formally recognised which can be distinguished using the following key.

Etymology: The specific epithet honours Keith R. Mcdonald, formerly of the Threatened Species Unit, Department of Environment & Heritage Protection, whose botanical collections have added much to the knowledge of the flora of Queensland.

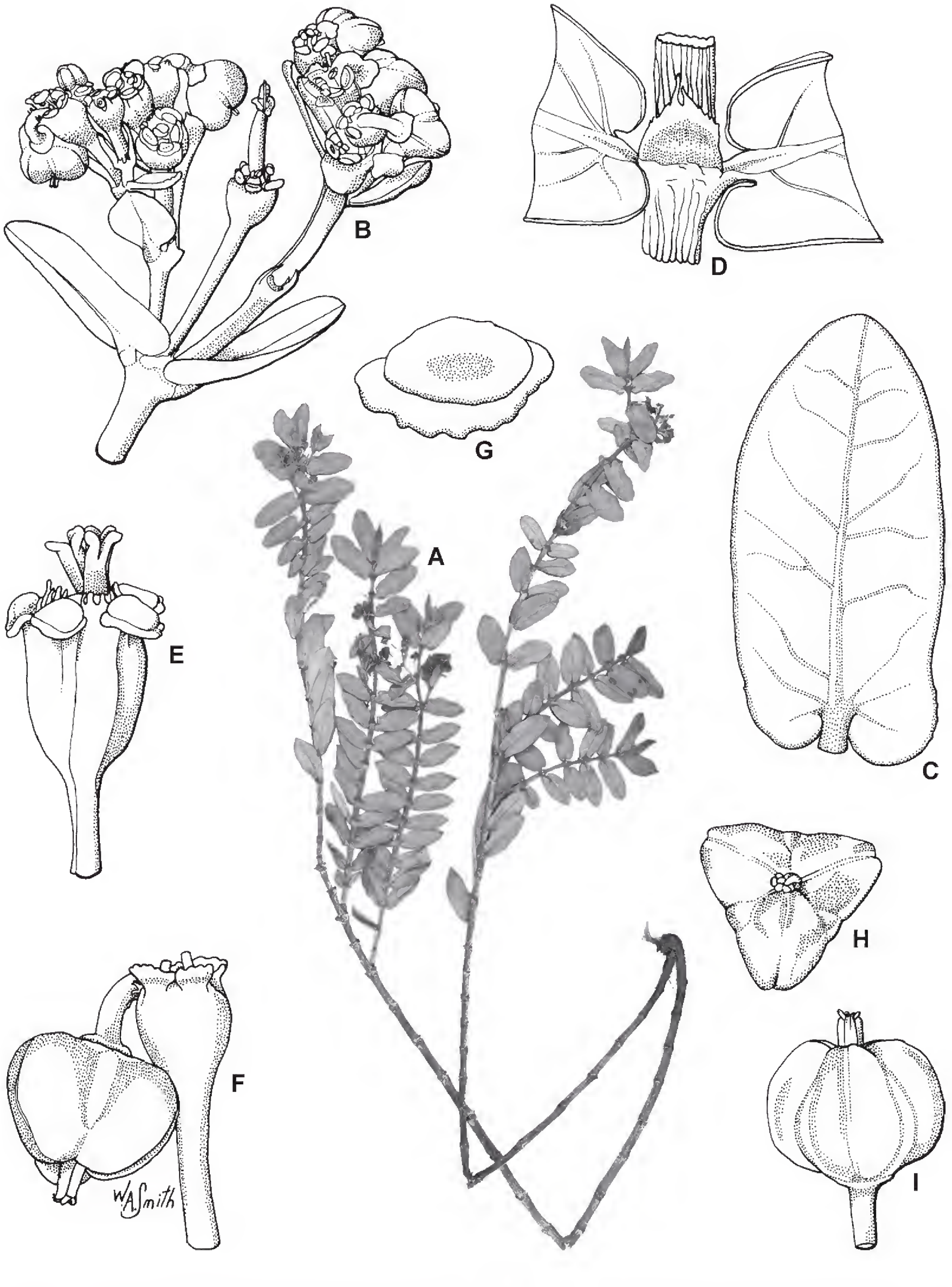

Fig. 11. ***Euphorbia litticola*****.** A. habit ×0.4. B. branchlet with cyathia ×3. C. leaf ×3. D. stipules ×6. E. cyathia with female flower ×12. F. capsule with cyathia ×6. G. cyathial gland with appendage, adaxial view ×24. H. capsule, top view ×6. I. capsule, lateral view ×6. A–D, F–I from *Forster PIF6113 & Petherick* (BRI); E from *Cowie et al. 2187* (DNA). Del. W.Smith.

Key to varieties of *Euphorbia macdonaldii*

Stems, leaves and capsules with a moderately dense to dense indumentum; hairs 0.1–0.5 mm long . . . . **27a. E. macdonaldii** var. **macdonaldii**

Stems, leaves and capsules glabrous or with a sparse indumenutm; hairs 0.5–1 mm long . . . . **27b. E. macdonaldii** var. **potentillina**

27a. Euphorbia macdonaldii var. macdonaldii

Euphorbia australis var. *canescens* Domin, *Biblioth. Bot.* 89(4): 310 (1927 '1926'). **Type:** Queensland. [North Kennedy District:] Mt Remarkable apud opp. Pentland, Feb 1910, *K.Domin s.n.* (holo: PR 528297).

Herbaceous perennials to 10 cm high, many stems arising from woody taproot. **Stems** prostrate or weakly ascending, moderately dense to dense hairy (hispid); hairs 0.1–0.5 mm long. **Leaves**: petiole 0.5–1 mm long; blade oblong-elliptic or oblong-obovate, 4–9.5 mm long, 2.5–5 mm wide, 1.4–1.9 times longer than wide; adaxial and abaxial surfaces smooth (rarely papillose), with a moderately dense indumentum consisting of hairs 0.1–0.3 mm long; margin toothed distally; apex rounded. **Involucres** 0.8–1.2 mm long, 0.7–1.3 mm across; glands 0.2–0.4 mm long, 0.3–0.6 mm wide, pink or cream to yellow; gland appendages transverse-oblong to transverse-linear, to 0.4 mm long, 0.5–0.8 mm wide, pink, margin dentate or irregularly shallowly lobed. **Staminate flowers** 5–15 per cyathium. **Capsules** shallowly 3-lobate with keels obtuse, ± smooth, sparsely to densely hairy; hairs spreading, 0.1–0.3 mm long. **Figs 12, 26L.**

***Additional selected specimens examined*: Northern Territory.** Nicholson River area, Jun 1974, *Henshall 379* (BRI, DNA). **Queensland.** Cook District: 16 km NW of Mt Garnet on Lappa Road, Jun 2000, *Forster PIF25802* (BRI); 13.5 km S along Lappa to Mt Garnet Road, Apr 2005, *Forster PIF30797 & McDonald* (BRI); 11.4 km along Sundown Road from junction with Kennedy Highway, Apr 2006, *McDonald KRM5072* (BRI); Pinchgut Creek, base of Pinchgut Hill, NE of Chillagoe, Mar 2005, *McDonald KRM3913 & Little* (BRI); 36 [km] SW of Mt Garnet beside the road to 'Sundown', Mar 2005, *Wannan 3888* (BRI); 11.5 km along Sundown Road to Almaden/Mt Surprise off Kennedy Highway, May 2006, *Forster PIF31477 & McDonald* (BRI); 28.8 km S along Lappa to Mt Garnet Road, Apr 2005, *Forster PIF30802 & McDonald* (BRI); 16 km NW of Mt Garnet, on road to Lappa, Jan 1993, *Bean 5462 & Forster* (BRI); Stannary Hills, 11 km S of Mutchilba, Portion 603, May 2006, *Forster PIF31590 & McDonald* (BRI); Stannary Hills, 9.5 km S of Mutchilba, Portion 603, May 2006, *Forster PIF31469 & McDonald* (BRI); Copperfield River, Kidston Goldmine Water Supply Dam, Gilbert Range, Feb 1994, *Forster PIF14891 & Bean* (BRI). North Kennedy District: 22.9 km S of turnoff to Einasleigh on Kennedy Developmental Road, Jul 2000, *Cumming 19867* (BRI); Humpybong track, High Range, *c.* 40 km SW of Townsville, Feb 1999, *Cumming 18617* (BRI); on track towards lottery turnoff, just W of Warrigal Creek, 7.2 km ESE of Flinders Highway, SW of Pentland, Aug 1988, *Cumming 8282* (BRI); Pentland, Jun 1934, *Blake 6061* (BRI); 100 km S of Charters Towers on road to Lornesleigh Station, May 2006, *Halford Q9079 & Batianoff* (BRI); Charters Towers, *s.d.*, *Plant 190* (BRI); 6 km E of Mt Cooper homestead, Jun 1992, *Thompson CHA133 & Sharpe* (BRI). South Kennedy District: Mt Coolon – Collinsville Road, 0.9 km E of Deception Creek – W side of road site 96/3, Jan 1996, *Champion 1296 & Pollock* (BRI).

***Distribution and habitat*:** *Euphorbia macdonaldii* var. *macdonaldii* is confined to north-eastern Qld, from near Chillagoe south to near Mt Coolon with a distjunct population in the Nicholson River area, NT (**Map 27a**). It grows in eucalypt woodland communities on sandy soils most often on rocky granitic hills, but also on rhyolitic or sandstone hills.

***Phenology*:** Flowers and fruits have been collected from January to August.

27b. Euphorbia macdonaldii var. potentillina (Baill.) Halford & W.K.Harris combinatio nova

27b. Euphorbia macdonaldii var. **potentillina** (Baill.) Halford & W.K.Harris **combinatio nova**; *Euphorbia australis* var. *potentillina* Baill., *Adansonia* 6: 283–284 (1866). **Type:** Queensland. *s.loc.*, *s.d.*, [*E.M.*] *Bowman s.n.* [*202/62*] (holo: P 698528, element top left hand corner, *n.v.* (image seen); iso: MEL 1560384).

Euphorbia australis var. *semiglabra* Domin, *Biblioth. Bot.* 89(4): 310 (1927 '1926'). **Type:** Queensland. [Cook District:] apud opp. Chillagoe, February 1910, *K.Domin s.n.* (lecto, [here designated]: PR 528301).

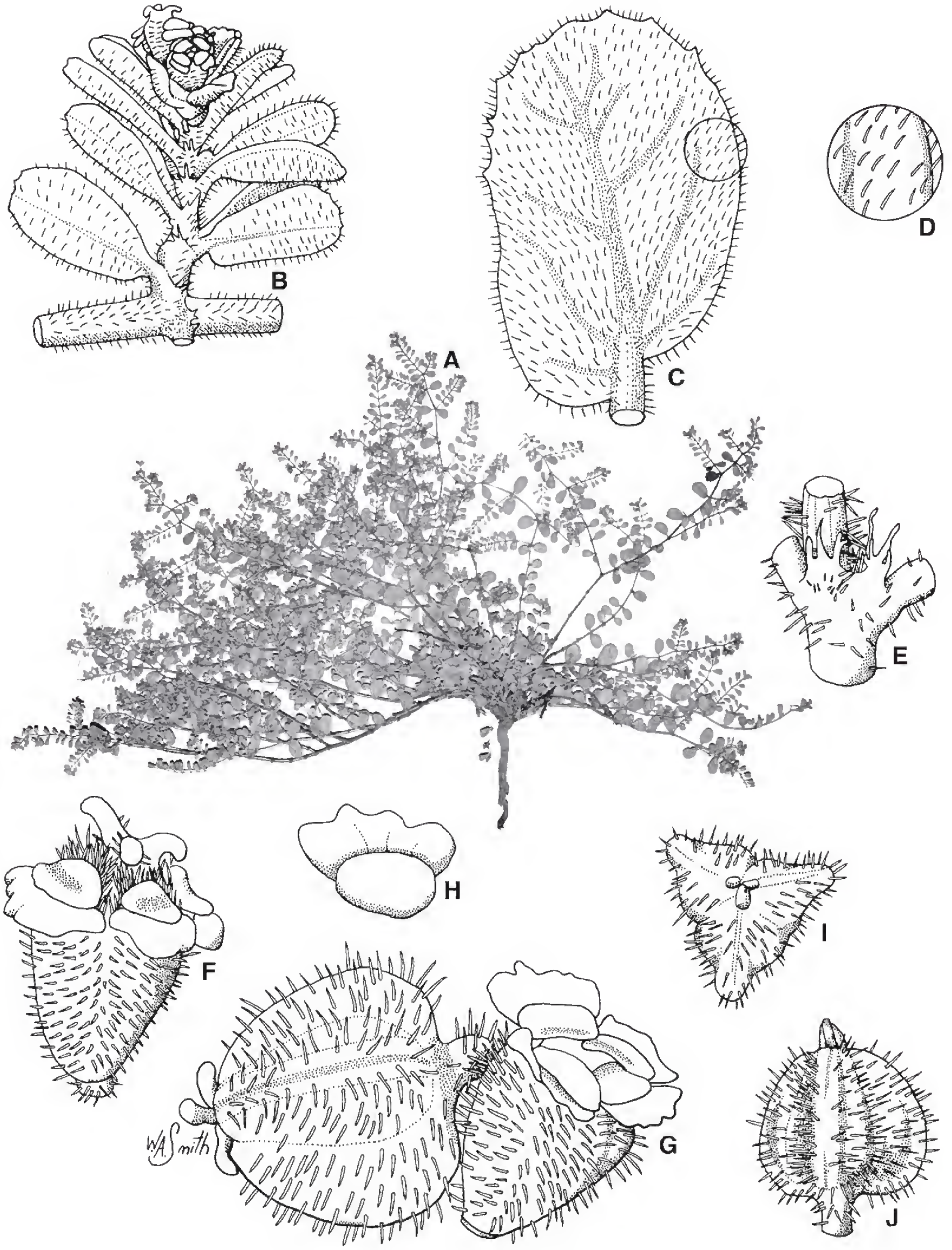

Fig. 12. ***Euphorbia macdonaldii*** *var.* ***macdonaldii***. A. habit ×0.4. B. branchlet with cyathia ×8. C. leaf ×8. D. indumentum on lower leaf surface ×16. E. stipules ×16. F. cyathia with female flower ×24. G. cyathial gland with appendage, adaxial view ×32. H. capsule with cyathia ×24. I. capsule, top view ×16. J. capsule, lateral view ×16. A from *Forster PIF31477 & McDonald* (BRI); B–D, F–J from *Forster PIF30732 & McDonald* (BRI); E from *McDonald KRM5072* (BRI). Del. W.Smith.

Herbaceous perennials to 15 cm high, with few to many annual stems arising from slightly thickened rootstock. **Stems** prostrate or ascending, sparsely hairy (pilose) (rarely glabrous); hairs 0.5–1.0 mm long. **Leaves**: petiole 0.4–1.2 mm long; blade oblong, elliptic to broad-elliptic, 5.5–9 mm long, 4.5–7 mm wide, 1–1.5 times longer than wide; adaxial and abaxial surfaces smooth, glabrous or with scattered hairs 0.5–1 mm long; margin serrulate to serrate; apex rounded to retuse. **Involucres** 0.9–1 mm long, 1–1.1 mm across; glands 0.2–0.3 mm long, 0.4–0.5 mm wide, pink; gland appendages transverse-oblong or lunate, 0.1–0.2 mm long, 0.7–0.8 mm wide, pink, margin entire or shallowly lobed. **Staminate flowers** 5 per cyathium. **Capsules** shallowly 3-lobate with keels acute, smooth or minutely papillose, glabrous. n = 11. **Fig. 26M.**

***Additional selected specimens examined*: Queensland.** COOK DISTRICT: 6.7 km along Pormpuraaw Road from Gulf Development Road junction near Musgrave, May 2010, *McDonald KRM9190* (BRI); on a hillside to the E of the road to the OK Mine, on Nychum Station and 15 km WSW of the homestead, Aug 2003, *Fox IDF2428* (BRI); 7.2 km by road towards Ootann from junction with Burke Development Road near Almaden, Jan 2005, *McDonald KRM3512* (BRI); 24 km W of Dimbulah, May 1976, *Hassall 7618* (BRI); 45 km by road S of Mt Garnet, Feb 2006, *McDonald KRM4795* (BRI); Mt Zero property, off Ewan – Laroona Road, *c.* 100 km W of Townsville, Feb 2005, *Cumming 23180* (BRI).

***Distribution and habitat*:** *Euphorbia macdonaldii* var. *potentillina* occurs from near Musgrave, Cape York Peninsula, south to the Paluma Range, Qld (**Map 27b**). It is recorded as growing in eucalypt woodland communities on sandy soils on small hills, most often on granite but also on rhyolite.

***Phenology*:** Flowers and fruits have been collected in January, February and August.

***Typification*:** Domin (1927) cited two of his collections in the protologue of *Euphorbia australis* var. *semiglabra* namely "Chillagoe (DOMIN II. 1910) ... Mungana (DOMIN II. 1910)". Two collections, which are considered as syntypes of the name *E. australis* var. *semiglabra*, have been located amongst material of *Euphorbia* on loan to BRI from PR [**a:** *Euphorbia australis* var. *typica*, Queensland: in xerodrymio apud opp. Mungana, Jan 1910, *Domin* (Iter Australiense nr 5741), (PR 528300); **b:** *Euphorbia australis* var. *typica*, Queensland: apud opp. Chillagoe, Feb 1910, Domin (Iter Australiense nr 5742) (PR 528301). The collection from near Chillagoe [PR 528301] is here selected as lectotype because it is part of the original material and has morphology that matches the description in the protologue of this variety. The syntype collected near Mungana (PR 528300) is referable to *E. schultzii* var. *comans*.

***Notes*:** *Euphorbia macdonaldii* var. *potentillina* differs from the typical variety by the characters set out in the key above.

28. Euphorbia maconochieana B.G.Thomson, *Nuytsia* 8: 354, 356, fig. 3 (1992). **Type:** Northern Territory. Cahill's Crossing, Victoria River crossing on the Top Springs to Victoria River Downs Road, 26 March 1990, *B.G.Thomson 3486* (holo: DNA *n.v.*; iso: AD *n.v.*, BRI, PERTH *n.v.*, *fide* Thomson [1992: 354]).

***Illustrations*:** Wheeler (1992: figs 184S, 185S, 186S), as *Euphorbia* sp. C; Thomson (1992: 355, fig. 3).

Monoecious, annual, few to many stems arising from the base. **Stems** prostrate, sparingly to much branched, ± smooth, with a sparse to moderately dense indumentum; hairs ± spreading or appressed, straight, crispate or curved, to 0.2 mm long, white. **Interpetiolar stipules** narrow-triangular, 0.4–1 mm long, bipartite, with indumentum as for stems; margin entire. **Leaves**: petiole *c.* 0.5 mm long, smooth, with indumentum as for stems; blade narrow-oblong to oblong, narrow-ovate to ovate or obovate, 7–16 mm long, 2–7 mm wide, 1.8–2.7 times longer than wide; adaxial surface colour unknown, smooth or papillose, glabrous or with a sparse to moderately dense indumentum consisting of spreading, straight or curved hairs to 0.1 mm long; abaxial surface colour unknown, smooth or papillose, with a sparse to moderately dense indumentum consisting of spreading, curved hairs to 0.3 mm long; base asymmetric with one side cordate, the other cuneate; margin sparingly minutely to coarsely toothed or entire; apex rounded, obtuse or acute. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 1–2.5 mm long, smooth, with indumenutm as for stems. **Involucres** cupuliform, 1.3–1.5 mm long, 1.5–1.8 mm across; lobes 5, triangular, 0.5–0.8 mm long, margin fimbriate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong or transverse-elliptic in outline, 0.3–0.4 mm long, 0.4–0.5 mm wide, pink to dark red; gland appendages conspicuous, spreading radially, reniform, (0.1)0.3–1.5 mm long, 0.5–1.7 mm wide, white or rarely pale pink, glabrous, margin entire; bracteoles 0.9–1.6 mm long, adnate for *c.* 1/2 of their length to involucre, free portion divided into numerous subulate hirsute segments. **Staminate flowers** 15–32 per cyathium; pedicels 1–1.4 mm long; staminal filaments 0.4–0.5 mm long. **Pistillate flowers**: styles 0.7–1 mm long, connate at the base into a column for *c.* 1/8 of their length, erect with spreading apices, papillose proximally, glabrous, each bifid for 1/3–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3.5 mm long, very broad-ovate or broad-elliptic in lateral view, 1.7–1.8 mm long, 1.7–2.2 mm across, shallowly 3-lobate with keels obtuse, papillose, glabrous or sparsely hairy; hairs spreading, *c.* 0.1 mm long; hypogynous disc entire. **Seeds** ovate in outline, 1–1.1 mm long, 0.6–0.8 mm tangentially, 0.6–0.7 mm radially, tetraquetrous to tetragonous in cross section; dorsal faces convex; ventral faces planar or slightly concave; all faces with faint narrow rounded irregular ridges; exotesta thin, of even thickness over surface, pale brown, microreticulate, becoming mucilaginous when moistened; endotesta brown. **Fig. 26N.**

Additional selected specimens examined**: Western Australia.** drain 7, Packsaddle Creek, Aug 1973, *Kenneally 1941* (PERTH); Smoke Creek, SW of Lake Argyle, May 1980, *Weston 12185* (PERTH); Nicholson Road, off Duncan Highway, Apr 1993, *Done s.n.* (PERTH 2984318); 47 km S of Forrest River crossing on Duncan Highway, Apr 1977, *Eichler 22400* (MEL); 3 km SE of Brooking Gorge, Apr 1988, *Cranfield 6438* (PERTH); Bow River Diamond Mine, 200 km S of Kununurra, Apr 1991, *Barrett BR14* (PERTH); Kununurra, Mar 1978, *Aplin 6286b* (PERTH). **Northern Territory.** 10 km NNE of Twins Mount on Palm Creek, Mar 1989, *Leach 2376 & Dunlop* (DNA); 46 miles [*c.* 74 kn] SW of Birrimbah Outstation, Jun 1949, *Perry 2078* (DNA); Gregory Creek, Mar 1992, *Brocklehurst 615* (DNA); Auvergne Station, plot 923, Mar 1998, *Harwood 437 & Brocklehurst* (DNA); Newry Station, 37 km E of WA/NT border, along Victoria Highway, Apr 1989, *Halford H61* (BRI, DNA); 5 km W [of] Top Springs Roadhouse, Mar 1990, *Thomson 3489* (BRI); 51 miles [*c.* 82 km] E [of] Victoria River Downs, May 1959, *Chippendale 6095* (DNA, MEL); 4 miles [*c.* 6 km] S of Willeroo Outstation, Jun 1949, *Perry 2025 & Lazarides* (BRI, DNA, MEL); 3 km W [of] Top Springs Roadhouse, Mar 1990, *Thomson 3488* (DNA); Victoria River District, site 30, Apr 1990, *Manning 569* (DNA); Kalkaringi, Mar 1990, *Thomson 3491* (DNA); Kelly Station, May1994, *Egan 3937* (BRI, DNA); 10 km S [of] Victoria River Crossing, between Top Springs and Timber Creek, Jul 1974, *Carr 2730 & Beauglehole 46509* (MEL, NSW).

Distribution and habitat**:** *Euphorbia maconochieana* extends from Brooking Gorge near Fitzroy Crossing, Kimberley, WA, north east to the Fitzmaurice River and east to Wavehill Station, in the north-western part of the NT (**Map 28**). It grows in grassland or occasionally in open woodland communities, on dark heavy clays on plains or low rolling hills.

Phenology**:** Flowers and fruits have been collected from February to August with one collection in October.

Notes**:** *Euphorbia maconochieana* is similar to *E. papillifolia* but differs from that species in having longer styles, distinctly papillose capsules and smaller seeds.

29. *Euphorbia maculata L., *Sp. Pl.* 455 (1753); *Chamaesyce maculata* (L.) Small, *Fl. S.E. U.S. [Small]* 713 (1903). **Type:** “habitat in America sepientrionali” (lecto: LINN [*Herb. Linn. No. 630.11*] *n.v.* (image seen) (IDC microfiche 177. 320: III. 3), *fide* Croizat [1962: 191]).

Euphorbia supina Raf., *Amer. Monthly Mag.* 2: 119 (1817); *Chamaesyce supina* (Raf.) Moldenke, *Annot. Classified List Moldenke Collect. Numbers* 135 (1939). **Type:** North America, not designated.

Illustrations**:** Lin *et al.* (1991: 240, fig. 15) as *Chamaesyce maculata*; Weber (1986: 749, fig. 401K); James & Harden (1990: 429), as *Chamaesyce supina*; Jeanes (1999: 61, fig. 9J).

Monoecious, annual to 10 cm high, many stems arising from slender taproot. **Stems** prostrate to weakly ascending, much branched, with a moderately dense indumentum on one side, smooth; hairs spreading or ascending-spreading, curved, to 0.8 mm long, white. **Interpetiolar stipules** subulate, 1–2.3 mm long, deeply bipartite; glabrous or with a few hairs on margin; margin entire or laciniate proximally. **Leaves**: petiole 1–1.8 mm long, smooth, with indumentum as for stems; blade narrow-oblong to oblong, 5–13 mm long, 2–4.5 mm wide, 1.7–4 times longer than wide; adaxial surface green to blue green, usually with elongated red spot centrally and reddish tinge along margins, smooth, glabrous; abaxial surface pale green, smooth, with a sparse to moderately dense indumentum consisting of appressed-ascending to spreading, curved hairs 0.3–0.5 mm long; base asymmetric with one side rounded to auriculate, the other cuneate to obtuse; margin serrulate; apex acute to obtuse or rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.4–1 mm long, smooth, with a few scattered hairs or glabrous. **Involucres** turbinate, 0.4–0.8 mm long, 0.5–0.8 mm across; lobes (4)5, triangular, 0.2–0.4 mm long, margin fimbriate; glands 4, stipitate, cupuliform, with shallow central pit, transverse-oblong in outline, 0.1–0.15 mm long, 0.2–0.3 mm wide, pink, cream or yellowish green; gland appendages conspicuous, spreading radially, transverse-oblong, 0.1–0.3 mm long, 0.3–0.7 mm wide, white or pink, glabrous, margin entire or irregularly shallowly lobed; bracteoles 0.5–0.7 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into few subulate hirsute segments. **Staminate flowers** 4–5 per cyathium; pedicels 0.6–1 mm long; staminal filaments 0.1–0.15 mm long. **Pistillate flowers**: styles 0.3–0.5 mm long, spreading, smooth, glabrous, each bifid for *c.* 1/3 of their length, apices clavate. **Capsules** exserted from involucre on pedicel to 2.3 mm long, very broad-ovate to depressed ovate in lateral view, 1.5–1.6 mm long, 1.5–1.8 mm across, shallowly 3-lobate with keels acute, smooth or minutely papillose, with a sparse to moderately dense indumentum; hairs appressed, 0.1–0.2 mm long; hypogynous disc entire. **Seeds** ovate or broad-ovate in outline, 0.8–1 mm long, 0.6–0.7 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal and ventral faces ± planar or concave, with 2–5 rounded transverse ridges; exotesta thin, of even thickness over surface, pale brown or grey-white, microreticulate, becoming mucilaginous when moistened; endotesta red-brown. **Fig. 26O.**

***Additional selected specimens examined*: Western Australia.** Broome, Sep 1992, *Kenneally KFK11346* (PERTH); South Perth, Apr 1982, *Perry 1294* (PERTH); Narrogin, Mar 2002, *Warren 654 & Rose* (PERTH). **Queensland.** MARANOA DISTRICT: Cavanough Park, St George, Feb 2004, *Halford Q8108 & Harris* (BRI). DARLING DOWNS DISTRICT: 200 m S of Mackenzie Road on Stanthorpe bypass, Apr 2002, *Halford Q7512 & Batianoff* (BRI). MORETON DISTRICT: Brisbane Botanic Gardens, Mt Coot-tha, Jan 1999, *Halford Z1753* (BRI). **South Australia.** Lofty South, 25 Canopus Avenue, Hope Valley, Jan 1989, *Alcock 11028* (AD, BRI); 59 Thomas Street, Unley, Adelaide, Feb 1984, *Symon 13784* (AD, BRI); 21 Para Road, Evanston, Mar 1976, *Alcock 5361* (AD). **New South Wales.** Tamworth City Council Nursery, Oxley Park, Tamworth, Apr 1999, *Hosking 1707 & Bayliss* (MEL); Botanic Gardens, Sydney, Feb 1976, *Rodd 3021* (BRI, NSW); Buronga, Silver City Highway, near the bottle shop at Stanley Wineries, Dec 2000, *Browne 1126* (NSW). **Australian Capital Territory.** Australian National Botanic Gardens, Feb 1990, *Telford 10899* (AD, MEL). **Victoria.** Cobram township, Apr 2001, *McManus s.n.* (MEL 2096409); St James Parade, Elsternwick, Melbourne, Apr 1985, *LeBreton 25* (MEL, NSW); South Yarra, Royal Botanic Gardens, Mar 1998, *Clarke 2865* (MEL).

***Distribution and habitat*:** *Euphorbia maculata* is most likely native to North America, but has become widely naturalised around the world. In Australia it is naturalised in all mainland States (**Map 29**). It grows in mostly urban areas on roadsides, in lawns, garden beds and pathways.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from December to May.

***Notes*:** In Australia, the name *Euphorbia thymifolia* L. has often been misapplied to this species (Anderson 1939; Jacobs & Pickard 1981; Stanley & Ross 1983). *Euphorbia maculata* can be distinguished from *E. thymifolia* by having capsules at maturity fully exserted from the involucre versus the capsules at maturity half included within the involucre causing the involucre to split in *E. thymifolia*. Another morphological difference between these two species is that the cyathial gland appendages of *E. thymifolia* are generally unequal in size versus mostly equal for *E. maculata* (P. Berry, *pers. comm.*). We have not observed this difference in the Australian collections of the two species.

Euphorbia maculata may be confused with another naturalised weedy species in Australia, *E. prostrata* Aiton. It differs from *E. prostrata* in having ± appressed hairs evenly spread over the capsules, whereas the hairs on the capsules of *E. prostrata* are spreading and confined to the keels.

30. Euphorbia mitchelliana Boiss., in A.DC., *Prodr.* 15(2): 25 (1862); *Chamaesyce mitchelliana* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. Port Curtis District:] Port Curtis [Gladstone area], November 1847, *J.MacGillivray 83* (lecto [here designated]: K 186478, element on left; isolecto: K 186479).

Monoecious, annual or herbaceous perennial with woody taproot, 80 cm high, few to many stems arising from rootstock. **Stems** prostrate, decumbent or erect (rarely rhizomatous), sparsely to densely hairy or glabrous, smooth; hairs ascending to spreading, crispate, 0.1–0.8 mm long, white. **Interpetiolar stipules** subulate, 0.6–1 mm long, entire or bipartite, glabrous or pubescent; margin entire or laciniate. **Leaves**: petiole 0.8–2 mm long, smooth, glabrous or with indumentum as for stems; blade linear to lanceolate, narrow-oblong to oblong, elliptic to broad-elliptic or ovate, 7–70 mm long, 1–12 mm wide, 1.5–30 times longer than wide; both surfaces smooth; adaxial surface dark green or subglaucous, glabrous or sparsely pilose with spreading, straight to crispate hairs 0.4–1.3 mm long; abaxial surface pale green or glaucous, glabrous or sparsely to densely pilose with ascending to spreading, crispate hairs 0.1–1.3 mm long; base symmetric or asymmetric, cordate or obtuse; margin entire or minutely serrulate distally with gland-tipped teeth; apex rounded, obtuse or acute. **Cyathia** in lax terminal dichasial cymes (sometimes becoming monochasial distally); bracts leaf-like but much smaller than the primary stem leaves, subulate to narrowly triangular; cyathial peduncles 1–6 mm long. **Involucres** turbinate or campanulate, 0.6–1.3 mm long, 0.7–1.8 mm across; lobes 5, triangular to subulate, 0.3–0.8 mm long, margin ciliate or laciniate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong to transverse-elliptic in outline, 0.1–1.2 mm long, 0.3–1.6 mm wide, yellowish green; gland appendages inconspicuous to conspicuous, spreading radially, broad-obovate, obdeltoid or oblong, 0.1–1.5 mm long, 0.5–2.2 mm wide, pink or white, glabrous, margin entire or shallowly to deeply irregularly lobed; bracteoles 0.5–0.6 mm long, adnate for 1/2–2/3 of their length to involucre, free portion divided into a few to many subulate glabrous or hirsute segments. **Staminate flowers** 5–50 per cyathium; pedicels 0.8–2.2 mm long; staminal filaments 0.2–0.6 mm long. **Pistillate flowers**: styles 0.4–1 mm long, spreading, smooth, glabrous, each bifid for 1/4–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2.7 mm long, transversely broad-elliptic in lateral view, 1.5–2 mm long, 1.6–2.3 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous or with a sparse to moderately dense indumentum consisting of spreading or appressed hairs 0.1–0.4 mm long; hairs mostly evenly distributed over capsule rarely confined to keels; hypogynous disc entire. **Seeds** ovate to elliptic in outline, 1.2–1.4 mm long, 0.8–1 mm tangentially, 0.8–1 mm radially, tetragonous or trigonal in cross section; dorsal faces convex; ventral faces convex or ± planar; all faces with 3–7 prominent narrow rounded transverse ridges; exotesta thin, of even thickness over surface, grey-white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown.

***Distribution and habitat*:** *Euphorbia mitchelliana* is widespread across northern Australia from One Arm Point, WA, eastward through northern parts of the NT to Maryborough, in south eastern Qld.

***Typification*:** Boissier (1862) in his protologue of *Euphorbia mitchelliana* states "Ad Port Curtis Australiae (Mitchell No. 231!, MacGillivray n. 83 et 63 in herb. Kew!)". Four sheets (five collections) which are considered as syntypes of the name *E. mitchelliana*, have been located amongst material of *Euphorbia* on loan to BRI from K [**a:** "[Queensland. Belyando River] bed of large sandy river, sub-tropical New Holland, 11 Aug 1846, Lieut.-Col. Sir T.L. Mitchell 231". There are two specimens on this sheet: element on left (K 186533) and an element on right (K 186532). The element K 186533 has attached to its stem a small label of white paper with "Euphorbia" and the letters "E.C.T." written in pencil. The writing on the label appears to be in Alan Cunningham's hand. Although it is certainly one of the elements used by Boissier in describing *E. mitchelliana* it is clearly not part of the *Mitchell 231* collection and not from the Belyando River area; **b: "**Voyage of Rattlesnake B. 63, Port Curtis, sandy beaches, Nov./47. J MG [J. McGillivray]" [K 186480]; **c:** "Vogage of Rattlesnake B. 83, Port Curtis, Nov./47, JMG[J. McGillivray]" [K 186478]. Also on this sheet is a *R.Brown* collection from the Northumberland Isles (K 186477). This is not considered to be part of the syntype material; **d:** "Vog of Rattlesnake B.83, Port Curtis, Dr McGillivray [ex herb Hook.]" [K 186479]. The collection (186478) is here selected as lectotype because it is part of the original material, is the more ample and complete of the five collections and has morphology that best matches the description in the protologue of this species. In 1989, B.G. Thomson annotated the K (186533) collection as lectotype but this was not published. All the syntypes are referable to *E. mitchelliana* var. *mitchelliana* as applied here.

***Notes*:** *Euphorbia mitchelliana* is similar to *E. bifida* in seed shape and seed surface ornamentation but differs from that in having cyathia in lax terminal dichasial cymes sometimes becoming monochasial distally.

As circumscribed here, *E. mitchelliana* is morphologically variable. There is considerable variation in the general habit of plants, vestiture, leaf shape and size, involucre shape, and gland appendages shape, size and degree of lobing. This variation is considered sufficient to warrant formal recognition of three varieties within this species which can be distinguished using the following key.

Key to varieties of *Euphorbia mitchelliana*

1 Involucres turbinate ≤1 mm across; staminate flowers <20 per cyathium; gland appendages small, to 0.6 mm long, usually narrower than or equal to gland width, toothed or deeply lobed . . **30a. E. mitchelliana** var. **mitchelliana**

1. Involucres campanulate, >1 mm across; staminate flowers usually 20–50 per cyathium; gland appendages large, 0.5–1.5 mm long, usually wider than gland width, entire or shallowly lobed **2**

2 Stems prostrate or decumbent; leaf blades ovate, elliptic to oblong-elliptic, 10–40 mm long, 5–12 mm wide, 1.5–4.5(6) times as long as wide . . . . **30b. E. mitchelliana var. filipes**

2. Stems erect to ascending, rarely prostrate; leaf blades linear to narrow-oblong, or narrow-lanceolate, 14–45 mm long, 2–7 mm wide, 5.5–20 times as long as wide . . . . **30c. E. mitchelliana var. longiloba**

30a. Euphorbia mitchelliana var. mitchelliana

Euphorbia mitchelliana var. *hirta* Boiss., in A.DC., *Prodr.* 15(2): 25 (1862); *Chamaesyce mitchelliana* var. *hirta* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland.] bed of large sandy river [Belyando River], 11 August 1846, *Lieut.-Col. Sir T.L.Mitchell 231* (holo: K 186532, element on the right).

Euphorbia mitchelliana var. *oblongifolia* Boiss., in A.DC., *Prodr.* 15(2): 25 (1862). **Type:** [Australia.] Nova Holl. , *s.d.*, *F.Bauer s.n.* (holo: W).

Euphorbia mitchelliana var. *cairnsiana* Domin, *Biblioth. Bot.* 89(4): 307 (1927 '1926'). **Type:** Queensland. [Cook District:] in silvis mixtis apud opp. Cairns solo arenoso, December 1909, *K.Domin s.n.* (lecto [here designated]: PR 528276).

Euphorbia mitchelliana var. *dietrichiae* Domin, *Biblioth. Bot.* 89(4): 307(1927 '1926'). **Type:** [Queensland. Moreton District:] prope Brisbane River, 1863–1865, *A.Dietrich 1882* (lecto [here designated]: PR 528274; isolecto: HBG 516202 *n.v.* (image seen), LD 1045446 *n.v.* (image seen)).

Euphorbia mitchelliana var. *filifolia* Domin, *Biblioth. Bot.* 89(4): 307 (1927 '1926'). **Type:** Queensland. [Cook District:] in xerodrymio ad pedem montis Metal Mts apud opp. Chillagoe, February 1910, *K.Domin s.n.* (holo: PR 528279).

Slender annual or herbaceous perennial with few to many stems arising from woody rootstock, to 60 cm high. **Stems** decumbent to erect (rarely prostrate), sparsely hairy or glabrous. **Leaf blades** linear to narrow-oblong or narrow-lanceolate (rarely elliptic), 15–60 mm long, 1–10 mm wide, (2.5)7–30 times as long as wide, glabrous or sparsely hairy on both surfaces; apex rounded, obtuse or acute. **Involucres** turbinate, 0.6–1 mm long, 0.7–1 mm across; glands 0.1–0.3 mm long, 0.3–0.6 mm wide; gland appendages inconspicuous to conspicuous, broad-obovate or oblong, 0.1–0.6 mm long, 0.5–0.6 mm wide, pink or white, margin toothed or deeply lobed. **Staminate flowers** 5–15 per cyathium. **Capsules** glabrous or with a sparse indumentum consisting of appressed hairs. *n* = 8. **Fig. 26P.**

***Additional selected specimens examined*: Western Australia.** 95 km W along Gibb River Road from the Great Northern Highway, Apr 1989, *Halford H27* (BRI); 4 km SW of One Arm Point, Apr 1992, *Carter 509* (PERTH); 2 km NW One Arm Point, Jan 1989, *Carter 346* (DNA, PERTH). **Northern Territory.** Grant Island, Apr 1995, *Booth 638* (DNA); Douglas Daly Research Farm, Jan 1998, *Michell 503* (DNA); old BHP flying strip, Arnhem Land, Jun 1972, *Symon 7729* (AD); Bickerton Island, South Bay, Apr 1993, *Cowie 3881 & Leach* (DNA); *c.* 29 miles [*c.* 46 km] NE [of] Maranboy Police Station, Mar 1965, *Lazarides 19 & Adams* (DNA, MEL); Rose River, Gulf of Carpentaria, Jul 1972, *Dunlop 2701* (DNA); Limmen Bight River upper reaches, Jan 1989, *Thomson 2860* (DNA); 80 km SW [of] Elliott, Feb 1989, *Thomson 3210* (DNA). **Queensland.** Cook District: 5 km E of Irvinebank near Jumna Mine, Feb 2004, *McDonald KRM1750* (BRI); 5.2 km E of Davies Creek Road from Kennedy Highway, Apr 1992, *Neldner 3843* (BRI). Burke District: 75.5 km by road from junction of Gulf and Burke Development Roads, towards Croydon, Jan 2005, *McDonald KRM3470* (BRI); *c.* 6 km SW of Normanton along the road to 'Mogoura' Station, Apr 1974, *Pullen 8842* (BRI, NSW). North Kennedy District: Castle Hill, Townsville, Feb 1992, *Bean 4032* (BRI); near Mt Woodhouse, SW of Ayr, Oct 1950, *Blake 18657* (BRI). South Kennedy District: just E of Great Dividing Range, *c.* 36 km NNW of Yarrowmere Station homestead, Oct 1983, *Henderson H2872 et al.* (BRI). Mitchell District: 37 km W of Jericho on the Jericho – Barcaldine Road, Jul 1975, *Beeston 1249C* (BRI). Gregory North District: Hamilton River, 5 km NW of 'Toolebuc', Jun 1978, *Purdie 1209* (BRI). Port Curtis District: near Castle Tower N.P., *c.* 19.5 km NW of Bororen, May 1995, *Thompson CAL215 & Turpin* (BRI).

***Distribution and habitat*:** *Euphorbia mitchelliana* var. *mitchelliana* is widespread across northern Australia from One Arm Point, WA, eastward through northern NT to Maryborough, south-eastern Qld (**Map 30a**). It grows in a wide variety of Melaleuca/eucalypt woodland/open forest communities on rocky hills, plains or coastal dunes. The soils are mostly sandy in texture and derived from a variety of substrates.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Typification*:** Domin (1827) in his protologue of *E. mitchelliana* var. *cairnsiana* states "Nordost-Queensland: Mischwälder liei Cairns, auf Sand (Domin XII. 1909)". Two sheets (PR 528273, PR 528276), which are considered by us as syntypes of the name *E. mitchelliana* var. *cairnsiana*, have been located amongst material of *Euphorbia* on loan to BRI from PR. The collection (PR 528276) is here selected as lectotype because it is part of the original material, is the more ample and complete of the two sheets and has morphology matching the description in the protologue of this variety. Both syntypes are referable to *E. mitchelliana* var. *mitchelliana* as applied here.

Domin (1827) in his protologue of *Euphorbia mitchelliana* var. *dietrichiae* states "Queensland: s.l., A. Dietrich No. 640, 873, 925, 988, 1882; Savannenwälder bei Mareeba und zwischen Chillagoe und dem Walsh River (Domin II. 1910)". A total of seven sheets [*A.Dietrich 640* (PR 528284); *A.Dietrich 873* (PR 528275); *A.Dietrich 925* (PR 528282); *A.Dietrich 988* (PR 528285); *A.Dietrich 1882* (PR 528274); Feb 1910, *K.Domin s.n.* (PR 528271); Feb 1910, *K.Domin s.n.* (PR 528272), which are considered by us as syntypes of the name *E. mitchelliana* var. *cairnsiana*, have been located amongst material of *Euphorbia* on loan to BRI from PR. The collection *A.Dietrich 1882* (PR 528274) is here selected as lectotype because it is part of the original material, the more ample and complete of the syntypes seen and has morphology that best matches the description in the protologue of this variety. All the syntypes are referable to *E. mitchelliana* var. *mitchelliana* as applied here.

***Notes*:** *Euphorbia mitchelliana* var. *mitchelliana* has leaf blades that are typically linear to narrow-oblong, or narrow-lanceolate. Leaf blades of collections from the central Qld coast and growing on coastal sands are generally elliptic in outline and resemble those of *E. mitchelliana* var. *filipes*. Some representative specimens of this variant are: PORT CURTIS DISTRICT: Statue Bay, *c.* 5 km SSE of Yeppoon, Aug 1976, *Henderson H2407* (BRI); Curtis Island, N of Southend towards Connor Bluff, Mar 1966, *Blake 22558* (BRI, MEL), Port Curtis [Gladstone area], Nov 1847, *MacGillivray 63* (K).

30b. Euphorbia mitchelliana var. **filipes** (Benth.) Halford & W.K.Harris **combinatio et status nova**; *Euphorbia filipes* Benth., *Fl. Austral.* 6: 51 (1873); *Euphorbia macgillivrayi* var. *filipes* (Benth.) Domin, *Biblioth. Bot.* 89(4): 311 (1927 '1926'); *Chamaesyce filipes* (Benth.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. BURKE DISTRICT:] Sweers Island, *s.d.*, *D.Henne s.n.* (lecto [here designated]: K 186472; isolecto: K 186469, MEL 2189021).

Euphorbia alsiniflora Baill., *Adansonia* 6: 288 (30 July 1866); *Chamaesyce alsiniflora* (Baill.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. BURKE DISTRICT:] Bentink [Bentinck] Island, *s.d.*, *s.coll.* (lecto [here designated]: P 313099; isolecto: G-DC *n.v.* (microfiche IDC 800-73. 2419: II. 2)).

Herbaceous perennial to 50 cm high, with woody taproot, few to many stems arising from rootstock. **Stems** prostrate, decumbent (rarely erect), densely hairy or glabrous. **Leaf blades** ovate, elliptic to oblong-elliptic, 10–40 mm long, 3–12 mm wide, 1.5–4.5(6) times as long as wide; glabrous or sparsely to densely hairy on both surfaces, margin entire; apex rounded, obtuse. **Involucres** campanulate, 0.8–1.2 mm long, 1.2–1.5 mm across; glands 0.4–0.5 mm long, 0.4–0.7 mm wide; gland appendages conspicuous, broad-obovate, obdeltoid, 0.5–1.5 mm long, 1.1–2.2 mm wide, white, margin entire or shallowly lobed. **Staminate flowers** stamens 20–50 per cyathium. **Capsules** glabrous or with a sparse to moderately dense indumentum consisting of spreading hairs. $n = 8$.

***Additional selected specimens examined*:** **Northern Territory.** Greenhill Island, Apr 1994, *Taylor 168* (DNA); North Goulburn Island, May 1992, *Dunlop 9052* (DNA); Little Mooroongga Island, Jun 1996, *Booth 1981* (DNA); Mouth of Glyde River, Dhipirrinjura, Jun 1996, *Booth 1840* (DNA); Bremer Island, Jul 1992, *Leach 2995* (DNA); Nyanantu Creek near mouth, Jan 1989, *Thomson 2886* (BRI, MEL, NSW); West Island, Sir Edward Pellew Group, Aug 1988, *Thomson 2694* (BRI); Vanderlin Island, Sir Edward Pellew Group, Jul 1988, *Thomson 2544* (DNA); 13 miles [*c.* 21 km] SSW [of] Borroloola, Jun 1971, *Dunlop 2202* (DNA); SE of Calvert River mouth, Jan 1989, *Brock 446* (DNA). **Queensland.** COOK DISTRICT: Mapoon Beach, S of Port Musgrave, Dec 1980, *Morton AM1011* (BRI, MEL); Weipa, Nanam Beach, Jul 1980, *Morton AM767* (BRI); Lake Patricia, Weipa, Dec 1993, *Forster PIF14412* (BRI); Edward River Mission, Jun 1968, *Pedley 2690* (BRI). BURKE DISTRICT: 77 km N of Escott homestead by track, towards Point Parker. Jul 1987, *Dalliston HC251* (BRI); Sweers Island, South Wellesley Islands, southern Gulf of Carpentaria, Nov 2002, *Thomas SW13 & Pedley* (BRI); North Bountiful Island, South Wellesley Group, Gulf of Carpentaria, Nov 2002, *Thomas BO152 & Pedley* (BRI); 10 km W [of] Massacre Inlet, Wentworth Station, Dec 1984, *Thompson 855* (BRI).

***Distribution and habitat*:** *Euphorbia mitchelliana* var. *filipes* occurs along the northern coast of Australia from Coburg Peninsula, NT, eastward to Weipa, Qld (**Map 30b**). It grows mostly in grassland, open woodland or on the edge of monsoon vine thicket on sandy soils on coastal floodplain, dunes or beach ridges.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Typification*:** Bentham (1873) in his protologue of *E. filipes* states "N. Australia, Islands of the Gulf of Carpentaria, R. Brown, Henne; Fitzmaurice river, F. Mueller". Four collections (K 186469, 186470, 186471, 186472) which are considered by us as syntypes of the name *E. filipes*, have been located amongst material of *Euphorbia* on loan to BRI from K. The collection (K 186472) is here selected as lectotype because it is part of the original material, has morphology that best matches the description in the protologue of this variety. All of the syntypes [K 186469, 186470, 186471, 186472] are referable to *E. mitchelliana* var. *filipes* as applied here.

Baillon (1866) cited two collections in his protologue of *Euphorbia alsiniflora* namely "N.? Bentink island (herb. Mus., ex herb. F. Muell.!). – Martin", "Mount King, Glensly river (herb. F. Muell.!)". Two collections (MEL 68196, P 313099) which are considered by us as syntypes of the name *E. alsiniflora*, have been located amongst material of *Euphorbia* on loan to BRI from MEL and P [**a:** Mount King, Glensly [Glenelg] River, [*Dr. J.*]*Martin s.n.* (MEL 68196); **b:** Bentink [Bentinck] Island, [without date or collector] (P 313099). The collection from Bentinck Island (P 313099) is here selected as lectotype because it is the more ample and best preserved of the syntypes and has morphology that best matches the description in the protologue of this species. In 1989, B.G. Thomson annotated the collection from Mount King, *Martin s.n.* [MEL 68196] as lectotype but this was not published. Due to the poor quality of the material and lack of seed we are unable to confidently identify the *Martin s.n.* [MEL 68196] collection. It is most likely referable to either *E. trigonosperma* or *E. biconvexa*.

***Notes*:** *Euphorbia mitchelliana* var. *filipes* differs from the typical form by having larger involucres (0.8–1.2 × 1.2–1.5 mm versus 0.6–1 × 0.7–1 mm for *E. mitchelliana* var. *mitchelliana*), more staminate flowers per cyathia (20–50 per cyathia versus 5–15 per cyathia for *E. mitchelliana* var. *mitchelliana*) and larger gland appendages (0.5–1.5 × 1.1–2.2 mm versus 0.1–0.6 × 0.5–0.6 mm for *E. mitchelliana* var. *mitchelliana*). For features distinguishing *Euphorbia mitchelliana* var. *filipes* from *E. mitchelliana* var. *longiloba* see the 'Notes' section under that variety.

30c. Euphorbia mitchelliana var. **longiloba** Halford & W.K.Harris, **varietas nova** ab *E. mitchelliana* Boiss. var. *mitchelliana* involucro majore 1–1.3 × 1.2–1.8 mm (ad vicem involucro 0.6–1 × 0.7–1 mm longo) floribus staminatis pluribus 35–50 in quoque cyathio) ad vicem floribus 5–15 in quoque cyathio) appendicibus glandulae plerumque majioribus 0.5–1.5 × 0.5–1.7 mm (ad vicem appendicibus 0.1–0.6 × 0.5–0.6 mm) necnon ab *E. mitchelliana* var. *filipedi* (Benth.) Halford & W.K.Harris foliis linearibus usque angusto-oblongis vel angusto lanceolatis 5.5–20 plo longiorbus quam latioribus (ad vicem foliis ovatis ellipticis usque oblongo-ellipticis 1.5–4.5(6) plo longioribus quam latioribus) differt. **Typus:** Northern Territory. 40 km W [of] Seven Emus, 22 January 1989, *B.G.Thomson 2948* (holo: BRI, according to label information on the holotype sheet there are duplicates (isotypes) lodged at DNA *n.v.*, NT *n.v.*).

Euphorbia pubicaulis S.Moore, *J. Bot.* 64: 97 (1926). **Type:** [Northern Territory.] Groote Eylandt, March 1925, *G.H.Wilkins 175* (holo: BM 812173).

Herbaceous perennial to 80 cm high, with many stems arising from woody rootstock. **Stems** erect to ascending (rarely prostrate or rhizomatous), glabrous (rarely sparsely hairy). **Leaf blade** linear to narrow-oblong, or narrow-lanceolate, 14–45 mm long, 2–7 mm wide, 5.5–20 times longer than wide; both surfaces glabrous (rarely sparsely hairy); margin entire or minutely serrulate distally with gland-tipped teeth; apex acute. **Involucres** campanulate, 1–1.3 mm long, 1.2–1.8 mm across; glands 0.1–0.5 mm long, 0.3–0.8 mm wide; gland appendages conspicuous, broad-obovate, obdeltoid, 0.5–1.5 mm long, 0.5–1.7 mm wide, pink or white, margin entire or shallowly lobed. **Staminate flowers** 35–50 per cyathium. **Capsules** glabrous. *n* = 8.

***Additional selected specimens examined*: Western Australia.** Dillon's Spring, Oct 1906, *Fitzgerald s.n.* (NSW 612843). **Northern Territory.** North Goulburn Island, Apr 1995, *Booth 808* (DNA); Tin Camp Creek, Nov 1991, *Brennan 1635* (DNA); 24 miles [*c.* 38 km] E [of] OT Downs homestead, Mar 1959, *Chippendale 5527* (BRI, DNA, MEL, NSW); Mooroongga Island, Garmalatjirrna Outstation, Aug 1995, *Cowie 5967* (DNA); 10 km S of Roper River mouth, Nov 1987, *Dunlop 7364* (DNA); Allia Creek, Feb 1989, *Dunlop 7967 & Leach* (BRI, MEL); 25 km E [of] Bulman, Arnhem Land, Jun 1990, *Dunlop 8657 & White* (AD, BRI, MEL); Banyella, Blue Mud Bay, May 1993, *Dunlop 9419 & Leach* (DNA); 15 km S of Elliott, Jan 1993, *Egan 1349* (DNA); N of Nhulunbuy, Oct 1993, *Egan 2698* (BRI, DNA); Nhulunbuy, mine rehabilitation site, Feb 1982, *Hinz s.n.* (BRI [AQ512374], DNA [D0051128], MEL 1583977); *c.* 40 km SSW of Nathan River homestead, Aug 1985, *Latz 10104* (AD, DNA); 7 miles [*c.* 11 km] NE of Legune Station, Jul 1949, *Perry 2585 & Lazarides* (BRI, DNA, MEL); Sir Edward Pellew Islands, West Island, Jan 1989, *Russell-Smith 6742 & Lucas* (MEL); Boomerang Creek, Merlin Mining Lease, Apr 1996, *Smith 3810* (DNA); 40 km NNW [of] Wollogorang homestead, Jan 1989, *Thomson 3021* (DNA). **Queensland.** COOK DISTRICT: Wenlock, Batavia River, Jul 1948, *Brass 19689* (BRI); 13.6 km W of the track from Rutland Plains to Inkerman on the track to White Waterhole, May 1992, *Clarkson 9538 & Neldner* (BRI). BURKE DISTRICT: Westmoreland, off road past Hells Gate, May 1997, *Forster PIF21071 & Booth* (BRI); 169 km S of Normanton, May 1976, *Hassall 7636* (BRI).

***Distribution and habitat*:** *Euphorbia mitchelliana* var. *longiloba* occurs from near Wyndham WA, through northern NT to the Qld border, with scattered occurrences on Cape York Peninsula, Qld (**Map 30c**). It grows in eucalypt woodland or open forest communities on hills or plains on mostly sandy soils, also recorded growing on coastal sand dunes.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia mitchelliana* var. *longiloba* resembles the typical form in leaf size and shape but differs from the that by having larger involucres (1–1.3 × 1.2–1.8 mm versus 0.6–1 × 0.7–1 mm for *E. mitchelliana* var. *mitchelliana*), more staminate flowers per cyathia (35–50 per cyathia versus 5–15 per cyathia for *E. mitchelliana* var. *mitchelliana*) and generally larger gland appendages (0.5–1.5 × 0.5–1.7 mm versus 0.1–0.6 × 0.5–0.6 mm for *E. mitchelliana* var. *mitchelliana*). *Euphorbia mitchelliana* var. *longiloba* differs from *E. mitchelliana* var. *filipes* by having leaves linear to narrow-oblong, or narrow-lanceolate, that are 5.5–20 times as long as wide (versus leaves ovate, ellipitc to oblong-elliptic, 1.5–4.5(6) times as long as wide for *E. mitchelliana* var. *filipes*.

***Etymology*:** The varietal epithet is from Latin *longus*, long, and *lobus*, lobe, in reference to the longer gland appendages of this variety compare to the gland appendages of the type variety.

31. Euphorbia muelleri Boiss., in A.DC., *Prodr.* 15(2): 27 (1862). **Type:** [Northern Territory.] tropical Australia, *s.d.*, *F.Mueller s.n.* (holo: K 186485; iso: P 698540 *n.v.* (image seen).

***Illustration*:** Dunlop *et al.* (1995: 218, fig. 72).

Monoecious (rarely dioecious), herbaceous perennial, few to many annual stems arising from thickened woody rootstock. **Stems** prostrate (rarely erect, *Leach 3258* [DNA]), smooth, glabrous or with a sparse to dense indumentum; hairs spreading, straight, 0.1–0.3 mm long, white. **Interpetiolar stipules** narrow-triangular to broad-triangular, 0.4–1.5 mm long, entire, bifid to deeply bipartite, glabrous or hairy abaxially with hairs as for stems; margin entire or lacerate with gland-tipped teeth. **Leaves**: petiole 0.4–2 mm long, smooth, glabrous or with indumentum as for stems; blade ovate to broad-ovate or elliptic to rotund, (4) 9–20 (27) mm long, (3) 7–16 (18) mm wide, 1–1.4 times longer than wide; adaxial surface green occasionally with reddish tinge, smooth, glabrous (rarely with indumentum as for abaxial surface); abaxial surface pale green or red, smooth, mostly with a sparse to moderately dense indumentum consisting of spreading, straight hairs to 0.2 mm long (rarely glabrous); base asymmetric with one side rounded to shallowly cordate, the other obtuse or rounded; margin entire; apex rounded to obtuse or retuse. **Cyathia** solitary at the nodes; peduncles 3–11 mm long, smooth, glabrous or with indumentum as for stems. **Involucres** cupuliform to turbinate, 1.5–2.5 mm long, 1.7–2.8 mm across; lobes 5, triangular, 0.7–1.4 mm long, margin entire or ciliate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong or reniform in outline, 0.3–0.6 mm long, 0.8–1.5 mm wide, colour unknown; gland appendages conspicuous, spreading radially, elliptic, broad-obovate to very broad-obovate or transverse-oblong, 0.6–1.5 mm long, 1.3–3.5 mm wide, white, glabrous, margin entire or shallowly lobed; bracteoles 1.7–2 mm long, adnate for *c.* 1/2 of their length to involucre, free portion deeply divided into numerous subulate hirsute segments. **Staminate flowers** 50–60 per cyathium; pedicels 2.1–2.5 mm long; staminal filaments 0.4–0.6 mm long. **Pistillate flowers**: styles 0.8–1 mm long, ascending, spreading distally, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices clavate. **Capsules** exserted from involucre on pedicel to 10 mm long, transversely broad-elliptic in lateral view, 2.8–3.5 mm long, 3.5–3.8 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous or sparsely hairy; hairs spreading, to 0.2 mm long; hypogynous disc entire. **Seeds** ovate or broad-ovate in outline, 1.9–2.7 mm long, 1.6–2 mm tangentially, 1.5–1.9 mm radially, tetragonous in cross section; dorsal faces convex; ventral faces ± planar; all faces with faint narrow irregular ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilagionous when moistened; endotesta brown. **Fig. 26Q.**

***Additional selected specimens examined*: Northern Territory.** Finniss River Road to Litchfield N.P., Sep 1992, *Leach 3258* (DNA); Lowther Road, Virginia, Nov 1984, *Wightman 1769* (DNA); Howard River floodplain, E side of Gunn Point Road, Mar 2001, *Cowie 9059* (BRI); 8 miles [*c.* 13 km] NE [of] Humpty Doo, Jun 1972, *McKean B550* (DNA); Shoal Bay Road, Aug 1973, *Parker 144* (DNA); Koongarra area, Apr 1979, *Rankin 2026* (DNA); Muirella Park, Kakadu N.P., Dec 1980, *Dunlop 5623* (DNA); 2 km N of Nabarlek airstrip, Apr 1979, *Rankin 2211* (DNA); Nabarlek, Nov 1988, *Hinz 56* (DNA); *c.* 7 km S of Daly River Road from Blackfellow Creek crossing, Tipperary Station, Aug 1986, *Strong 925* (DNA); 1.5 km W [of] Wangi Falls, Oct 1984, *Sivertsen 972* (DNA); Daly River Mission area, Mar 1993, *Wightman 6024* (DNA); Litchfield N.P., Lost City Road, Mar 1994, *Egan 3358* (DNA); Litchfield Park, Jun 1998, *Michell & Risler 1588* (DNA); 11.2 miles [*c.* 18 km] S [of] Batchelor, Mar 1961, *Chippendale 7728* (DNA, MEL, NSW); 2 km N of Hayes Creek, Nov 1987, *Smith 890* (DNA); Kakadu N.P., 6 km E of South Alligator River, Old Darwin road, Nov 1986, *Cowie 432* (DNA); 35 km SSW of Cooinda on Pine Creek Road, May 1980, *Craven 5602* (DNA); Mann River; *c.* 5 km S [of] headwaters, Jun 1992, *Wilson 1451* (DNA); Kakadu Highway, 600 m from Pine Creek Road junction, Nov 1991, *Brennan 1618* (DNA).

***Distribution and habitat*:** *Euphorbia muelleri* is restricted to the northern part of the NT, from the Finniss River area, east to Nabarlek (**Map 31**). It grows in eucalypt woodland/open forest or *Melaleuca* woodland communities on mostly sandy soils on rocky ridges, hillslopes or plateaux.

***Phenology*:** Flowers and fruits have been collected in March, April, June and from August to December.

***Notes*:** *Euphorbia muelleri* is a distinctive species that bears a general resemblance to *E. pallens* but differs from it by having larger seeds, capsules and cyathia, longer gland appendages, more staminate flowers per cyathia, seed surface with faint narrow irregular ridges and cyathia solitary at the nodes. It also grows in a different habitat.

32. Euphorbia multifaria Halford & W.K.Harris, **species nova** habitu generali glandulis involucri et glandulae appendicibus arcte similis *E. verrucitestae* Halford & W.K.Harris sed capsulis majoribus lato-ellipticis 1.5–1.7 × 1.5–2.1 mm (ad vicem capsulis perlato-ovatis 1.3–1.5 × 1.5–1.7 mm) seminum superficiebus laevibus vel leviter irregulariter porcatis (ad vicem superficiebus verrucis irregularibus in seminis superficiebus ornatis) differt. Aliquae formae similis *E. ferdinandi* Baill. sed ab ea distinguendae seminibus latioribus 1.1–1.4 × 0.7–0.8 mm (ad vicem seminibus 1.1–1.6 × 0.5–0.7 mm) capsulis lato-ellipticis latis quam latioribus 1.5–1.9 × 1.5–2.1 mm (ad vicem ellipticis latis quam manifeste longioribus). *Euphorbia multifaria* quondam eadem atque *E. drummondii* Boiss. considerata est sed habitu plerumque minori seminum superficiebus laevibus vel porcatis leviter irregulariter (ad vicem superficiebus 3–6 porcis distinctis transversis) differt. **Typus:** South Australia. *c.* 27 km N of Kingoonya, 7 September 1966, *N.N.Donner 1684* (holo: AD).

Monoecious, annual or herbaceous perennial with thickened rootstock, to 10 cm high, many stems arising from base, the whole plant glabrous. **Stems** prostrate (rarely ascending to erect), smooth or often longitudinally ridged. **Interpetiolar stipules** triangular, 0.3–1 mm long, deeply bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.2–0.6 mm long, smooth; blade oblong, obovate, oblong-obovate or elliptic, 2.8–7 mm long, 1.6–3.8 mm wide, 1.8–1.9 times longer than wide; adaxial surface dull light blue-green often with reddish patches along the midline, smooth (rarely minutely papillose); abaxial surface green, smooth; base asymmetric with one side rounded to shallowly cordate, the other obtuse to cuneate; margin sparingly minutely toothed; apex rounded. **Cyathia** solitary at the nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.3–0.4 mm long, smooth. **Involucres** campanulate or turbinate, 0.5–0.6 mm long, 0.6–0.8 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin fimbriate; glands 4, stipitate, cupuliform, with distinct central pit and thickened rim, transverse-oblong or orbicular in outline, 0.1–0.3 mm long, 0.2–0.4 mm wide, red; gland appendages inconspicuous, spreading radially, transverse-linear, <0.1 mm long, *c.* 0.1 mm wide, pink, glabrous, margin entire; bracteoles 0.5–0.8 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into few subulate glabrous or hirsute segments. **Staminate flowers** 4–10 per cyathium; pedicels 0.7–1 mm long; staminal filaments *c.* 0.2 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, erect to ascending, smooth, glabrous, each entire to scarcely bifid or bifid for 1/3–1/2 of their length, the apices stout. **Capsules** exserted from involucre on pedicel to 2.7 mm long, broad-elliptic in lateral view, 1.5–1.9 mm long, 1.5–2.1 mm across, shallowly 3-lobate with keels obtuse, smooth (rarely minutely papillose), glabrous; hypogynous disc entire (rarely laciniate). **Seeds** ovate in outline, 1.1–1.4 mm long, 0.7–0.8 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal faces planar or concave; ventral faces concave; all faces smooth or with faint narrow irregular ridges; exotesta of even thickness over surface or sometimes thicker on ridges, microreticulate or microgranulate, grey-white or pale brown, becoming mucilaginous when moistened; endotesta pale brown to red-brown. $n = 11$. **Figs 13, 26R, 27A.**

***Additional selected specimens examined*: Western Australia.** 16.2 km W along road to Weano Gorge from Yampire Gorge to Juna Downs Road, Hamersley Range N.P., Jun 1989, *Trudgen 7000* (PERTH); Lake Mason Station, Jul 1941, *Bennett 3* (PERTH); Queen Victoria Spring, Mar 1992, *Pearson DJP1778* (PERTH); 6 km S of Mundrabilla Hotel, Sep 1984, *Downing 987* (PERTH); *c.* 16 km S of Norseman, Apr 1999, *Davis 8807* (PERTH); 44 km NE of Balladonia, Mar 1984, *Keighery 7328* (PERTH); 20.9 km S of Caiguna via Baxter's Memorial track, Aug 1983, *Fitzgerald s.n.* (PERTH 02846934). **Queensland.** WARREGO DISTRICT: 46 km SE [of] Charleville along Boatman Road, Mar 1976, *Purdie 87 & Boyland* (BRI); *c.* 10 miles [*c.* 16 km] N of Hungerford, May 1973, *Hassall 7331* (BRI). **South Australia.** 12 km S of Nefertiti Gate, Mobella Station, Sep 1995, *Badman 8146* (AD); 6 km W of Roxby Downs, Apr 1989, *Badman 2073* (AD); Knowles Cave, Nullarbor Plain, Feb 1967, *Symon 4648* (AD, NSW); Eyre Peninsula, Yudnapinna, Jul 1966, *Rogers 460* (AD); Koonamore Vegetation Reserve, 60 km N of Yunta, Jun 1968, *Carrick 1688* (AD, HO, MEL); *c.* 5 km ex Yunta on Waukaringa Road, Mar 1968, *Barker 252* (AD); Quondong, KiKi – Lilydale fence, Apr 1967, *Barker 24* (AD). **New South Wales.** Fowlers Gap, N of Broken Hill, Oct 1975, *Jacobs 2102* (NSW); 10.6 km NE of 'Glenoca' homestead, on road to 'Boorungie' homestead, 26 km NE of Little Topan Hotel, Oct 1971, *DeNardi 881* (NSW); 29 miles [*c.* 47 km] by road NNW of Wilcannia, on road to White Cliffs, May 1969, *Briggs 2709* (NSW); API Gypsum Mine, 'Marlow', 23 km NNW [of] Conoble Railway Station, Mar 1973, *Pickard 1944* (NSW); near Darling River, 16 km NNE of Wentworth and 2 km S of Tapio Station, Aug 1978, *Muir 5837* (MEL). **Victoria.** Meridian Road, 13 km S of Benetook, Sep 1981, *Corrick 7409* (AD, MEL).

***Distribution and habitat*:** *Euphorbia multifaria* is widespread in southern Australia from near Narrogin and Mount Magnet, WA, east through southern SA, north-western Vic and western NSW to near Mitchell, in southern Qld, with an outlier population in the Hamersley Range, north-western WA (**Map 32**). It commonly grows in shrubland or woodland communities on sandy soils on undulating plains or on aeolian dunes. It is also recorded on shallow soils on rocky slopes or outcrops, and in chenopod shrubland communities on clay soils on flats.

***Phenology*:** Flowers and fruits have been collected throughout the year.

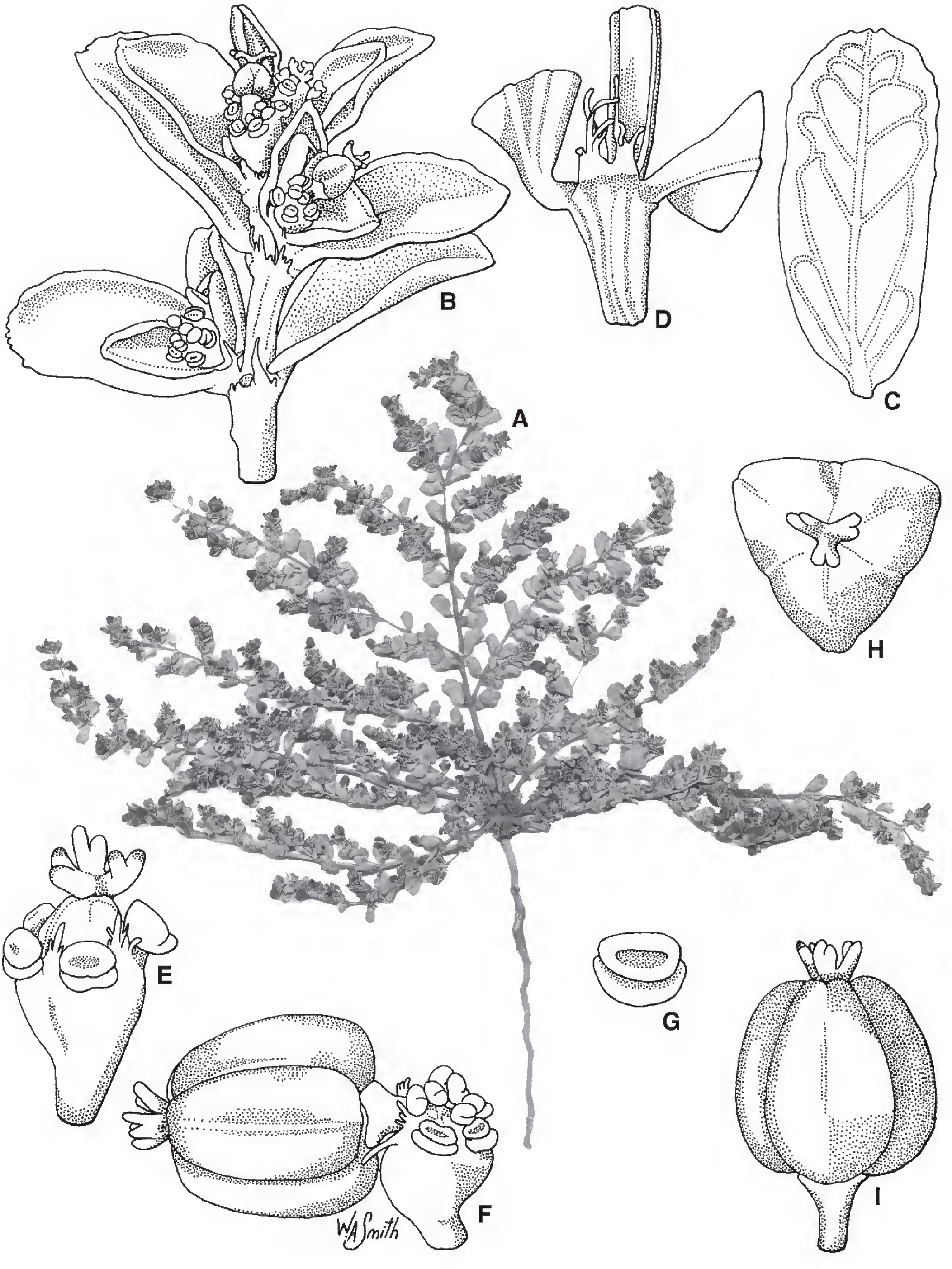

Fig. 13. ***Euphorbia multifaria***. A. habit ×1. B. branchlet with cyathia ×8. C. leaf ×8. D. stipules ×16. E. cyathia with female flower ×24. F. cyathia with capsule ×16. G. cyathial gland with appendage, adaxial view ×24. H. capsule, top view ×16. I. capsule, lateral view ×16. A from *Barker 24* (AD); B–I from *Donner 1684* (AD). Del. W.Smith.

Notes**:** *Euphorbia multifaria* is very similar to *E. verrucitesta* in its general habit, involucral glands and gland appendages. It differs from *E. verrucitesta* by its larger broad-elliptic capsules, 1.5–1.9 × 1.5–2.1 mm (versus capsules very broad-ovate, 1.3–1.5 × 1.5–1.7 mm for *E. verrucitesta*) and smooth or faintly irregularly ridged seed surfaces (versus irregular wart-like protuberances on the seed surface for *E. verrucitesta*).

Some forms of *E. multifaria* resemble *E. ferdinandi* but can be distinguished from that species by its broader seeds (1.1–1.4 × 0.7–0.8 mm versus 1.1–1.6 × 0.5–0.7 mm for *E. ferdinandi*) and broad-elliptic capsules that are as long as wide, 1.5–1.9 × 1.5–2.1 mm (versus capsules elliptic, 1.4–2.1 × 1.2–1.7 mm, that are distinctly longer than wide for *E. ferdinandi*).

Euphorbia multifaria has been previously identified as *E. drummondii* but differs from that species by having smooth or faintly irregular ridged seed surfaces (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*) and generally smaller habit.

As recognised here *Euphorbia multifaria* is a morphologically variable complex and with further collections and study may be subdivided into a number of taxa. One of the more recognisable variants has the seed surface faintly irregularly ridged with a chalky grey-white endotesta (**Fig. 27A**). This form has been recorded from Norseman, WA east across the Nullarbor Plain to Immarna Siding, SA (e.g. *Davis 8807*, *Keighery 7328*, *Symon 4648*). The more typical observed seed surface is smooth or faintly undulate (**Fig. 26R**) which is found throughout the species range.

Etymology**:** The specific epithet is from Latin, *multifarius*, having great variety, and is in reference to the variation of this species seed surface texture, and style architecture.

33. Euphorbia myrtoides Boiss. in A.DC., *Prodr.* 15(2): 15 (1862); *Chamaesyce myrtoides* (Boiss.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Western Australia.] Despard [Depuch?] Island, *s.d.*, [*B.*] *Bynoe s.n.* (holo: K 186487; iso: BM *n.v.* [image seen]).

Monoecious, herbaceous perennial 10–40 cm high, few to many stems arising from woody rootstock, the whole plant glabrous. **Stems** ascending to erect (rarely prostrate), sparingly to much branched, smooth. **Interpetiolar stipules** subulate or triangular, 0.3–1 mm long, bipartite, glabrous; margin laciniate or lacerate. **Leaves**: petiole 0.5–2.5 mm long, smooth; blade ovate, obovate, oblong or oblong-elliptic, 5–17 mm long, 3–9 mm wide, 1.5–2 times longer than wide; adaxial surface bright green or yellow-green, smooth; abaxial surface pale green or grey-green, smooth; base asymmetric with one side cordate, the other obtuse to rounded; margin entire or serrulate to serrate; apex rounded. **Cyathia** solitary at the distal nodes, sometimes clustered on short leafy lateral branchlets with subtending leaves slightly smaller than the primary stem leaves; peduncles 0.5–2.5 mm long. **Involucres** cupuliform, 0.8–1.1 mm long, 0.8–1.5 mm across; lobes 5, narrow-triangular to broad-triangular, 0.3–0.5 mm long, margin entire or fimbriate; glands 4, stipitate, patelliform, planar or concave, transverse-elliptic to reniform in outline, 0.3–0.6 mm long, 0.4–1.2 mm wide, yellow, yellow-green or red; gland appendages absent or conspicuous, spreading radially, transverse-oblong, 0.1–0.6 mm long, 1–1.3 mm wide, white, pink or red, glabrous, margin entire or dentate to shallowly lobed; bracteoles 1–1.2 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into few to numerous subulate glabrous or hirsute segments. **Staminate flowers** 12–30 per cyathium; pedicels 1.1–1.5 mm long; staminal filaments 0.1–0.4 mm long. **Pistillate flowers**: styles 0.5–0.9 mm long, connate at the base into a column for *c.* 1/5 of their length, spreading, smooth, glabrous, each bifid for 1/4–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 4.5 mm long, elliptic to broad-elliptic in lateral view, 2.2–2.8 mm long, 2.2–2.6 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, (1.3)1.5–2 mm long, 0.8–1.1 mm tangentially, 0.8–1.1 mm radially, tetraquetrous in cross section; dorsal faces planar or convex; ventral faces planar to concave; all faces with faint to prominent narrow irregular ridges; exotesta thin, of even thickness over surface, white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta brown. **Fig. 27B.**

Additional selected specimens examined**: Western Australia.** Pender Bay, Dampierland, 4.5 km NE [of] Cape Borda, Mar 1989, *Keighery 10573* (PERTH); 1 km from Port Smith camping area, Port Smith, Apr 1992, *Zich 154* (MEL, NSW); 1 km W of Mandora Station homestead, Aug 1997, *Mitchell PRP1779* (BRI, PERTH); 21 km NE of Sandfire Roadhouse, Great Northern Highway, Sep 1978, *Beauglehole ACB59327 & Errey* (PERTH); N of Dragon Tree Soak, Great Sandy Desert, Aug 1977, *George 14770* (PERTH); Back Beach, Karratha, July 1981, *Craig 265* (PERTH); Onslow, Feb 1985, *Dodd 171 & Madin* (PERTH); Onslow, Sep 2006, *Halford Q9294* (BRI); near Thels Well, Mardie Station, Aug 2002, *Thompson JPS164* (PERTH); near Lakes Percival and Wooloomba, Aug 1962, *Johnson s.n.* (DNA D9762); Tobin Lake, Great Sandy Desert, May 1979, *George 15641* (PERTH); near Norcape Lodge, Exmouth, Jul 1977, *McFarland s.n.* (BRI [AQ234287]); near S boundary of Cane River Station, 80 km SE of Onslow, May 1999, *Edinger 1495* (PERTH); Lake Auld, July 1967, *George 9144* (PERTH); Kennedy Range N.P., 30 km NE of Binthalya, Aug 1994, *Keighery & Gibson 1518* (PERTH); Muggon Station, N boundary of Spinifex Paddock, 3.7 km W of Spinifex Well, Sep 1999, *Patrick 3202 et al.* (PERTH); Cape Boileau, 35 km N [of] Broome, May 1991, *Thomson 3497* (DNA); Port Hedland, May 1991, *Thomson 3665* (DNA); Anketell Ridge, Great Sandy Desert, May 1979, *Mitchell 1160* (DNA).

Distribution and habitat**:** *Euphorbia myrtoides* occurs in north-western WA from Carnarvon to Derby and inland to the Great Sandy Desert (**Map 33**). It grows in open shrubland, or *Spinifex/Triodia* grassland communities on crests or upper slopes of coastal beach dunes and inland sand dunes.

Phenology**:** Flowers and fruits have been collected throughout the year, particularly from April to September.

Notes**:** The holotype at Kew has a label with hand written annotation in ink “Euphorbia, Despard Island, NW. Aust., Bynoe”. This locality appears to be erroneous. There is no record of an island of this name along the WA coast. Benjamin Bynoe was the surgeon on the voyage of the Beagle (1937–1843). Hall (1978) noted that Bynoe chiefly collected at Depuch Island and in the Abolhos in north-western Australia. Depuch Island is the most likely collection site for the type specimen. The isotype in the BM has a printed label “VOYAGE OF H.M.S. BEAGLE, 1839–40 PRESENTED 1842” with a hand annotation “Depuch Island, Bynoe Coll., Capts. Wickham & Stokes”.

There is variation in the prominence and degree of seed surface sculpturing and habit, but the variation grades from one form to another form.

Euphorbia myrtoides is morphologically most similar to *E. wheeleri* but can be distinguished from that by its faint to prominent narrow irregular ridges on the seed surface (versus foveate to reticulate-foveate seed surface for *E. wheeleri*).

Some of the southern populations of *Euphorbia myrtoides* approach *E. sharkoensis* in general facies; however, it can be distinguished from that species by its generally larger capsules and seeds.

34. Euphorbia obliqua Endl., *Prodr. Fl. Norfolk.* 85 (1833); *Chamaesyce obliqua* (Endl.) J.Florence, *Bull. Mus. Natl. Hist. Nat., B, Adansonia*, 18(3–4): 241 (1996). **Type:** Norfolk Island, *s.d.*, *F.L.Bauer s.n.* (holo: W *n.v.*).

Illustrations**:** Green (1993: 315, fig. 2, B1–3; 1994: 236, fig. 47, E–G).

Monoecious, herbaceous perennial, many stems arising from thickened woody rootstock. **Stems** prostrate, sparingly to much branched, smooth, glabrous. **Interpetiolar stipules** triangular to broad-triangular, 0.6–1 mm long, entire or bifid, glabrous abaxially, hairy adaxially with appressed hairs *c.* 0.1 mm long; margin dentate. **Leaves**: petiole 1–2 mm long, smooth; blade elliptic to broad-elliptic, 9–20 mm long, 6–10 mm wide, 1.2–1.8 times longer than wide; adaxial surface green to blue-green, smooth, glabrous, abaxial surface pale blue-green, smooth, glabrous, base asymmetric with one side cordate, the other obtuse to rounded or cordate; margin entire; apex obtuse to rounded. **Cyathia** solitary at the distal nodes; peduncles 2–3 mm long. **Involucres** turbinate, 1.3–2 mm long, 1–1.5 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin entire or laciniate; glands 4, stipitate, patelliform, ± planar, transverse-oblong in outline, 0.3–0.4 mm long, 0.6–0.7

mm wide, yellowish green; gland appendages conspicuous, spreading radially, transverse-linear or lunate, *c.* 0.1 mm long, 0.6–0.9 mm wide, white, glabrous, margin entire; bracteoles 1.3–1.5 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into numerous subulate hirsute segments. **Staminate flowers** 15–25 per cyathium; pedicels 1.1–1.6 mm long; staminal filaments 0.5–0.6 mm long. **Pistillate flowers**: styles 0.5–0.6 mm long, connate at the base into a column for *c.* 1/8 of their length, spreading, smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 4 mm long, very broad-ovate or transversely broad-elliptic in lateral view, 2.2–2.3 mm long, 2.5–3 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** very broad-elliptic in outline; 1.4–1.5 mm long; 1.2–1.4 mm tangentially, 1.2–1.3 mm radially, suborbicular in cross section; dorsal and ventral faces convex, smooth; exotesta thin, of even thickness over surface, chalky-white, microreticulate, not becoming mucilaginous when moistened; endotesta pale brown. **Fig. 27C.**

***Additional selected specimens examined*: Queensland.** North Kennedy District: Holbourne Island, Great Barrier Reef, 39 km from Bowen, Mar 1971, *Heatwole s.n.* (BRI [AQ7736]); Hayman Island, Jun 1934, *White 10181* (BRI); Deloraine Island, Nov 1985, *Batianoff 3479 & Dalliston* (BRI). South Kennedy District: Penrith Island, 70 km E of Mackay, Nov 1986, *Batianoff 6040* (BRI). Port Curtis District: North West Island, Aug 1968, *Baxter 977* (BRI); Masthead Island, May 1998, *Batianoff 980527* (BRI); Masthead Island, Great Barrier Reef, Capricorn Group, *c.* 56 km NE of Gladstone, Dec 1970, *Heatwole s.n.* (BRI [AQ6541]); Tryon Island, Great Barrier Reef, Capricorn Group, *c.* 106 km from Yeppoon, Aug 1971, *Heatwole s.n.* (BRI [AQ7777]); Capricorn Islands, Great Barrier Reef, Jan 1932, *Macgillivray s.n.* (BRI [AQ202444]); North West Island N.P., Great Barrier Reef Marine Park, May 2000, *Batianoff 205031* (BRI); North West Island, Aug 1979, *Nugent s.n.* (BRI [AQ454415]); Wilson Island, Great Barrier Reef, Capricorn Group, *c.* 91 km NE of Gladstone, Oct 1969, *Cameron s.n.* (BRI [AQ7790]); Wreck Island N.P., Great Barrier Reef Marine Park, May 2000, *Batianoff 205071* (BRI, NSW); Heron Island, Capricorn Group, Jun 1973, *Fosberg 55079* (BRI); Heron Island, Dec 1983, *Smith 834 & Heatwole* (BRI); Tryon Island, May 2000, *Batianoff 205042* (BRI); West Hoskyn Island N.P., May 2000, *Batianoff 205137* (BRI, NSW).

***Distribution and habitat*:** In the Western Pacific *Euphorbia obliqua* occurs on Norfolk Island, Vanuatu and New Caledonia (Green 1994). In Australia it occurs along the east coast of Qld from Bowen to Gladstone on continental islands and coral cays of the Great Barrier Reef (**Map 34**). It grows on coastal sands on frontal beach dunes.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia obliqua*, *E. litticola*, *E. pallens* and *E. psammogeton* all grow in very similar sandy foreshore habitats along the north and east coast of Australia but are allopatric in their distributions.

Euphorbia obliqua can be confused with *E. psammogeton*. It differs from that by its smooth seeds (versus faint irregular narrow rounded ridges), smaller gland appendages, to 0.1 mm long (versus 0.2–0.4 mm long for *E. psammogeton*), and solitary cyathia (versus cyathia in dichasial cymes for *E. psammogeton*).

In Qld, in the past, *Euphorbia obliqua* has been confused with *E. pallens* (previously referred to by the name *E. atoto* G.Forst.). It differs from that by its more slender habit, cyathia solitary in upper axils (versus cyathia arranged in terminal or axillary lax to congested dichasial cymes for *E. pallens*) and generally smaller leaves (9–20 × 6–10 mm versus 24–35 × 11–22 mm for *E. pallens*).

35. Euphorbia occulta Halford & W.K.Harris, **species nova** similis aliquantum *E. careyi* F.Muell. a qua glandularum appendicibus erectis cuculliformibus (ad vicem appendicibus aut absentibus aut radialiter extendentibus) glandis involucribus cupuliformibus lacuna centrali instructis (ad vicem appendicibus patelliformibus planis vel leviter concavis) bracteis involucribus obovatis (ad vicem bracteis oblongis usque triangularibus distinguenda. **Typus:** Queensland. Burke District: 12.3 km along Lake Moondara Road from Barkly Highway, N of Mt Isa, 1 July 2011, *D.Halford QM524A* (holo: BRI, iso: DNA, K, MEL, MICH, NT, *distribuendi*).

Dioecious, herbaceous perennial to 20 cm high, with many stems arising from woody rootstock. **Stems** decumbent to erect, much branched, smooth, with moderately dense to dense indumentum; hairs spreading, straight, to 0.1 mm long, white. **Interpetiolar stipules** triangular, *c.* 0.1 mm long, bifid or deeply bipartite, with indumentum as for stems; margin ± entire. **Leaves**: petiole 0.5–1 mm long, smooth, with indumentum as for stems; blade elliptic to broad-elliptic or ± rotund, 4–5 mm long, 2.8–5 mm wide, 1.2–1.5 times longer than wide; adaxial surface yellow-green, smooth, with moderately dense indumentum consisting of spreading, straight, hairs to 0.1 mm long; abaxial surface yellow-green, minutely papillose, with indumentum as for adaxial surface; base asymmetric with one side cordate to obtuse, the other rounded; margin sparingly serrulate distally; apex rounded to retuse. **Cyathia** solitary at the nodes; peduncles 0.2–0.5 mm long. **Involucres** turbinate, 0.7–1 mm long, *c.* 1 mm across; lobes 5, obovate, 0.8–1 mm long, margin laciniate distally; glands 4, sessile, cupuliform, with distinct central pit, transverse-oblong in outline, *c.* 0.1 mm long, 0.4–0.5 mm wide, yellow; gland appendages conspicuous, erect, transverse-oblong, 0.3–0.5 mm long, 0.7–0.9 mm wide, yellow, glabrous, margin irregularly lobed distally; bracteoles 1.3–1.5 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** *c.* 20 per cyathium; pedicels *c.* 0.8 mm long; staminal filaments *c.* 0.3 mm long. **Pistillate flowers**: styles 0.7–1.2 mm long, connate at the base into a column for *c.* 1/4 of their length, erect to spreading and slightly recurved distally, smooth, sparsely hairy, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 1.5 mm long, broad-elliptic or transversely broad-elliptic in lateral view, 2–2.5 mm long, 2–2.6 mm across, shallowly 3-lobate with obtuse keels, smooth, with moderately dense indumentum; hairs spreading, *c.* 0.1 mm long; hypogynous disc entire. **Seeds** ovate in outline, 1.3–1.5 mm long, 0.7–0.8 mm tangentially, 0.8–0.9 mm radially, tetragonous in cross section; dorsal faces ± planar; ventral facet concave; all faces with distinct rounded irregular ridges; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown. **Figs 14, 27D.**

***Additional specimens examined*: Queensland.** BURKE DISTRICT: 12.3 km along Lake Moondara Road from Barkly Highway, N of Mt Isa, Jul 2011, *Halford QM524B* (BRI, DNA, MEL, MICH); Rifle Creek Station, S of Mt Isa, May 2005, *Booth 3536 & Kelman* (BRI); Rifle Creek, S of Mt Isa, May 2005, *Booth 3536A & Kelman* (BRI); 10.6 km ENE of Rifle Creek Dam, Aug 2001, *Kelman & Kelman s.n.* (BRI [AQ641966]); Rifle Creek Station, 8 km ENE of River Creek Dam, Apr 2002, *Kelman s.n.* (BRI [AQ729647]).

***Distribution and habitat*:** *Euphorbia occulta* is known only from the rocky hills in the vicinity of Mt Isa, north-western Qld (**Map 35**). It grows in low open woodland of *Eucalyptus leucophloia* Brooker and *Corymbia aparrerinja* K.D.Hill & L.A.S.Johnson with a ground layer usually dominated by tussock grasses or *Triodia pungens* on stony skeletal loam soils.

***Phenology*:** Flowers and fruits have been collected in May, July and August.

***Notes*:** *Euphorbia occulta* somewhat resembles *E. careyi* from which it can be distinguished by its erect hood-like gland appendages (versus gland appendages spreading radially or absent for *E. careyi*), cupuliform involucral glands with distinct central pit, (versus patelliform with planar or shallowly concave for *E. careyi*), and obovate involucral bracts (versus ± oblong to triangular for *E. careyi*).

***Etymology*:** The specific epithet is from Latin, *occultus*, secret, hidden, in reference to the concealment of the involucral glands by the erect hood-like gland appendages of this species.

36. Euphorbia ophiolitica (P.I.Forst.) Y.Yang, *Taxon* 61: 783 (2012); *Chamaesyce ophiolitica* P.I.Forst., *Austrobaileya* 5: 711–712 (2000). **Type:** Queensland. PORT CURTIS DISTRICT: First Sugarloaf, 9.5 km W of Canoona, 1 March 1994, *P.I.Forster PIF15042 & A.R.Bean* (holo: BRI; iso: AD *n.v.*, DNA *n.v.*, MEL *n.v.*, *fide* Forster [2000: 711]).

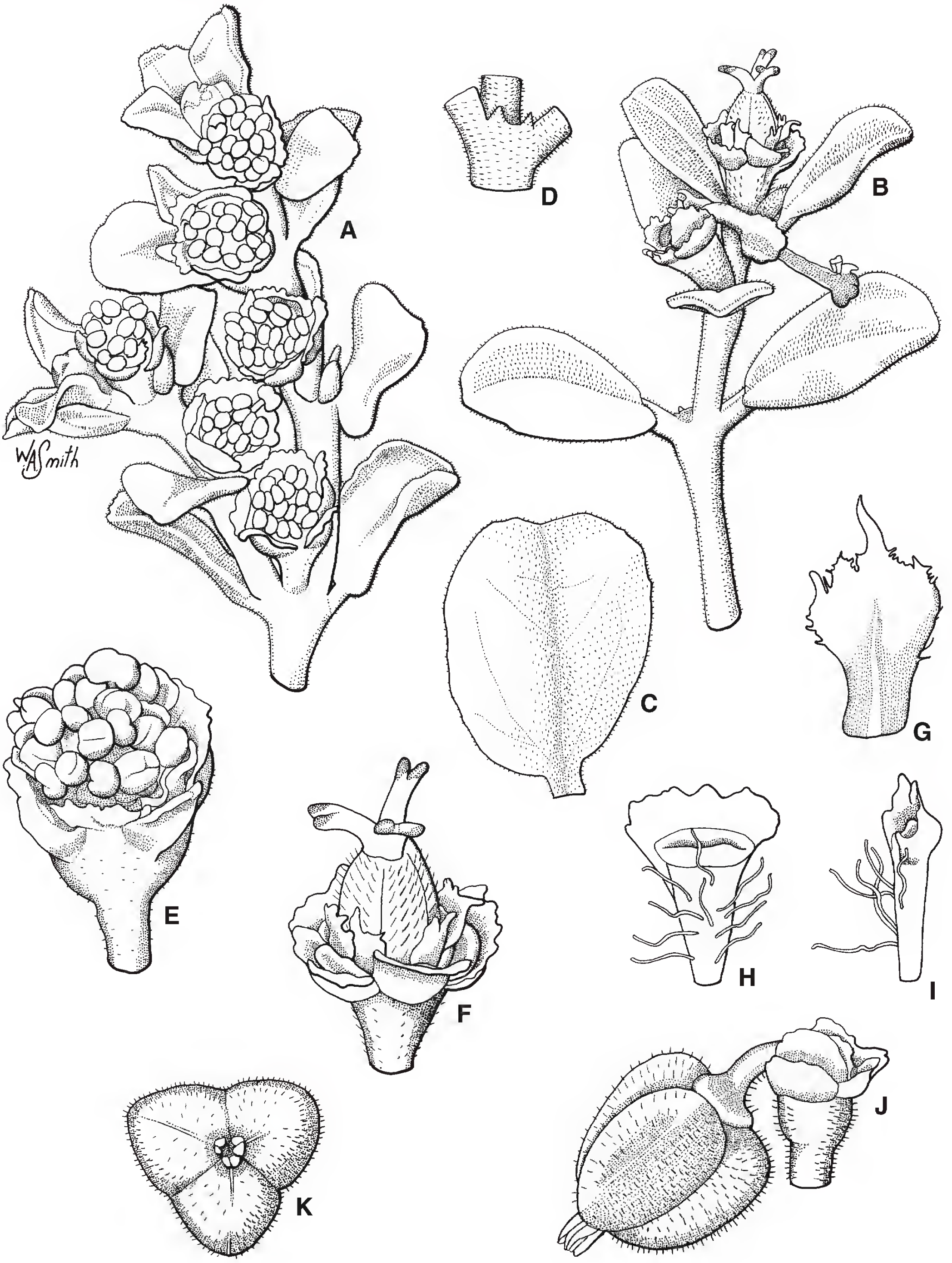

Fig. 14. ***Euphorbia occulta.*** A. branchlet with male cyathia ×8. B. branchlet with female cyathia ×8. C. leaf ×8. D. stipules ×16. E. cyathia with male flowers ×16. F. cyathia with female flower ×16. G. involucral bract ×32. H. cyathial gland with appendage, adaxial view ×16. I. cyathial gland with appendage, lateral view ×16. J. capsule with cyathia ×12. K. capsule, top view ×12. A, E & G from *Booth 3536A & Kelman* (BRI); B–D, F & H–K from *Booth 3536 & Kelman* (BRI). Del. W.Smith

***Illustration*:** Forster (2000: 713, fig. 1).

Monoecious or dioecious, annual or herbaceous perennial with slender woody taproot, few to many stems arising from rootstock. **Stems** prostrate, sparingly to much branched, longitudinally ridged, with a moderately dense indumentum or glabrous; hairs spreading, ± straight, 0.1–0.4 mm long, white. **Interpetiolar stipules** subulate to triangular, 0.2–0.6 mm long, entire or bipartite, glabrous or pubescent; margin laciniate. **Leaves**: petiole 0.5–1 mm long, smooth, with indumentum as for stems or glabrous; blade elliptic or broad-elliptic, 5–10 mm long, 4–8.5 mm wide, 1–1.5 times longer than wide; adaxial surface glaucous, blue-green sometimes red along margin, minutely papillose (visible at 40× mag.), with moderately dense indumentum consisting of spreading, straight hairs 0.1–0.3 mm long or glabrous; abaxial surface pale blue-green, with surface texture and indumentum as for adaxial surface; base asymmetric with one side cordate, the other obtuse to rounded; margin serrulate or sparingly minutely toothed distally; apex rounded. **Cyathia** solitary at the nodes; cyathial peduncles 0.2–2.5 mm long. **Involucres** campanulate, 0.8–1.4 mm long, 0.8–1.5 mm across; lobes (rarely 4)5, broad-triangular, 0.3–0.4 mm long, margin fimbriate; glands 4(rarely 5), stipitate, patelliform, planar or shallowly concave, transverse-oblong or reniform in outline, 0.4–0.5 mm long, 0.6–1 mm wide, pale green; gland appendages conspicuous, spreading radially, oblong, 0.4–0.5 mm long, 0.8–1.3 mm wide, white, glabrous, margin ± entire or shallowly lobed; bracteoles 0.6–0.8 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into subulate hirsute segments. **Staminate flowers** 20–25 per cyathium; pedicels 0.5–1.3 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, spreading, smooth, glabrous or minutely pubescent, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from the involucre on pedicel to 2.5 mm long, very broad-ovate or depressed ovate in lateral view, 1.6–2.6 mm long, 2.1–2.8 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous or with moderately dense indumentum; hairs evenly distributed over capsule, spreading, 0.1–0.2 mm long; hypogynous disc entire. **Seeds** ovate in outline, 1.7–1.8 mm long, 1–1.1 mm tangentially, 1–1.1 mm radially, tetragonous in cross section; dorsal faces convex; ventral faces planar or slightly concave; all faces with narrow rounded irregular or transverse ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown or red-brown. **Fig. 27E.**

***Additional selected specimens examined*: Queensland.** Port Curtis District: South Percy Island, 50 km NE of Arthur Point, Shoalwater Bay, Oct 1989, *Batianoff 11422 et al.* (BRI); Mt Wheeler, Rockhampton, Jan 1989, *Specht 3 & Reeves* (BRI, NSW); Gumigil Mining Lease, 18 km SSW of Marlborough, Jul 2000, *Champion 540 & Whereat* (BRI); on Rockhampton – Marlborough road, 50 km from Rockhampton, May 1960, *Johnson 1720* (BRI); 9.5 km W of Canoona, First Sugarloaf, Jan 1988, *Forster PIF3393* (BRI).

***Distribution and habitat*:** *Euphorbia ophiolitica* is restricted to central Qld, from Percy Isles (east of Mackay) to the Marlborough district (north of Rockhampton) (**Map 36**). It grows on stony hillsides or ridges, in open woodland or rarely grassland communities, on shallow stony soils derived from serpentinite rocks.

***Phenology*:** Flowers and fruits have been collected in January, May, July and October.

***Notes*:** *Euphorbia ophiolitica* is similar to *E. laciniloba* and *E. papillifolia*. For features distinguishing *E. ophiolitica* from those species, refer to the 'Notes' section under the species concerned.

37. *Euphorbia ophthalmica Pers., *Syn. Pl.* 2: 13 (1807); *Chamaesyce ophthalmica* (Pers.) D.G.Burch, *Ann. Missouri Bot. Gard.* 53: 98 (1966). **Type:** [Brazil.] Rio de Janeiro, [July 1767,] [*P.*] *Commerson* [*238*] (holo: P-JU *n.v.* [IDC microfiche 6206. 1187, II. 2]).

***Illustrations*:** Burger & Huft (1995: 19, fig. 6); Harris (2001: 32, fig. 2).

Monoecious, annual to 8 cm high, few to many stems arising from base. **Stems** prostrate, decumbent or weakly ascending, sparingly to much branched, smooth, moderately dense to densely hairy; indumentum consisting of white weakly appressed crispate hairs to 0.5 mm long interspersed with yellow spreading ± straight segmented hairs to 1.5 mm long. **Interpetiolar stipules** subulate to narrow-triangular, 0.5–2 mm long, bifid to deeply bipartite, sparsely hairy with white ascending hairs to 0.4 mm long; margin laciniate. **Leaves**: petiole 0.5–2.5 mm long, smooth, with indumentum as for stems; blade oblong or narrow-ovate to ovate, 6–15 mm long, 3–8 mm wide 1.5–2 times longer than wide; adaxial surface green occasionally with reddish tinge on margin, smooth, glabrous or sparsely hairy with white, spreading to ascending, ± straight hairs 0.6–0.9 mm long; abaxial surface pale green, smooth, with a moderately dense to dense indumentum of white, spreading to ascending, ± straight hairs to 1.2 mm long; base asymmetric with one side rounded, the other cuneate; margin serrulate; apex acute to obtuse. **Cyathia** in dense (10–30 cyathia) capitate, terminal cymose clusters to 10 mm in diameter on peduncles 1–7.5 mm long; bracts subulate to narrowly triangular, to 0.7 mm long; cyathial peduncles 0.5–1 mm long. **Involucres** turbinate, 0.6–0.8 mm long, *c.* 0.5 mm across; lobes 5, subulate, 0.1–0.2 mm long, margin laciniate; glands 4, stipitate, cupuliform, with shallow central pit and sometimes thickened rim, transverse-elliptic to orbicular in outline, *c.* 0.1 mm long *c.* 0.1 mm wide, pink or pale green; gland appendages present and conspicuous or absent, spreading radially, transverse-oblong, to 0.3 mm long and 0.3 mm wide, white, glabrous, margin irregularly lobed; bracteoles filamentous, 0.5–0.6 mm long, glabrous, entire or laciniate distally. **Staminate flowers** 2–5 per cyathium; pedicels 0.3–0.5 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.3–0.5 mm long, erect to spreading, smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices clavate. **Capsules** exserted from involucre on pedicel to 1.7 mm long, depressed ovate in lateral view, 0.8–1.5 mm long, 1.1–1.3 mm across, shallowly 3-lobate with keels acute, smooth, with moderately dense indumentum; hairs appressed, 0.1–0.2 mm long, evenly distributed over capsule; hypogynous disc entire. **Seeds** ovate in outline, 0.7–1 mm long, 0.5–0.6 mm tangentially, 0.4–0.5 mm radially, tetraquetrous in cross section; dorsal and ventral faces planar to concave; all faces with 5–7 faint narrow acute transverse ridges; exotesta thin, of even thickness, pale brown, microgranulate especially along ridges, becoming mucilaginous when moistened; endotesta pale red-brown. **Fig. 27F.**

***Additional selected specimens examined*: Queensland.** BURNETT DISTRICT: Walter Street, Kingaroy, Mar 2004, *Halford Q8170 & Edginton* (BRI). MORETON DISTRICT: Lookout, Dulong road, *c.* 4.5 km W of Nambour, Apr 2003, *Halford Q7510* (BRI); Brisbane Botanic Gardens, Mt Coot-tha, Mar 2000, *Harris 123* (BRI); between Woolley and Woodstock Streets, Taringa, 6 km from Brisbane GPO, Apr 2000, *Bean 16179* (BRI, MEL); Brisbane, Salisbury, Feb 2001, *Batianoff 210201* (BRI); 15 Whittaker Street, North Ipswich, Apr 1992, *Williams 92002* (BRI); 0.8 km along Sugarloaf Road, Warrill View, SSW of Ipswich, Nov 2000, *Bean 17023* (BRI); Newmarket end, Ashgrove Avenue, Newmarket, Brisbane, Mar 2000, *Forster PIF25475* (AD, BRI); Ormeau Railway Station, between Beenleigh & Nerang, May 2003, *Bean 20384* (BRI); Guanaba, Coomera River, 5 km SW of Oxenford, property I. Cairns, Apr 2003, *Forster PIF29300* (BRI); 8 km S of Canungra on road to O'Reillys, near winery, Mar 2003, *Fechner s.n. & Holland* (BRI [AQ733643]). **New South Wales.** Far North Coast Council depot, Wyrallah Road, East Lismore, Nov 2000, *Hosking 1965 & Scott* (BRI).

***Distribution and habitat*:** *Euphorbia ophthalmica* is a native of southern Florida, the West Indies and Argentina and is naturalised in Australia. In Australia it occurs from Gladstone, Qld south to Lismore, NSW (**Map 37**). It grows along roadsides, in garden beds or lawns.

***Phenology*:** Flowers and fruits have been collected from November to May.

***Notes*:** *Euphorbia ophthlamica* is easily distinguished from the native Australian *Euphorbia* species by its indumentum of long yellowish coloured hairs on stems and petioles. *Euphorbia ophthalmica* is closely related to *E. hirta*, but may be distinguished by its slender, prostrate habit, generally shorter leaf blade (blade to 1.5 cm long compared with blade to 4.5 cm long for *E. hirta*), and terminal cymose glomerules compare with axillary and terminal for *E. hirta*.

38. Euphorbia pallens Dillwyn, *Rev. Hortus Malab.* 54 (1839); *Chamaesyce pallens* (Dillwyn) V.S.Raju, *J. Econ. Taxon. Bot.* 28: 92 (2004). **Type:** [India]. illustration of Ben-Pala, Rheede, *Hort. Malab.* 10: 115, t. 58 (1690).

***Illustrations*:** Lin *et al.* (1991: 224, fig 4), as *Chamaesyce atoto*; Forster (1994: 9, fig 3–5) as *Euphorbia atoto.*

Monoecious, herbaceous perennial to 50(80) cm high, few to many stems arising from thickened woody rootstock. **Stems** ascending to erect or prostrate, much branched, smooth, often with whitish bloom glabrous. **Interpetiolar stipules** triangular, 1–1.5 mm long, abaxial surface glabrous or hairy with white ascending hairs *c.* 0.1 mm long, adaxial surface hairy with white ascending hairs *c.* 0.1 mm long; margin lacerate or fimbriate. **Leaves**: petiole 1.5–2.7 mm long, smooth; blade oblong, ovate or elliptic, 24–35 mm long, 11–22 mm wide, 1.4–2.7 times longer than wide; adaxial surface blue-green or pale green with whitish bloom, smooth or minutely papillose, glabrous abaxial surface pale blue-green sometimes with reddish tinge, smooth glabrous, base asymmetric with one side cordate, the other obtuse or shallowly cordate; margin entire; apex obtuse to rounded or retuse, sometimes with apiculate tip. **Cyathia** in congested 2–5 branched dichasial cymes together with a solitary cyathium at the distal nodes; peduncles 5–20 mm long; bracts leaf-like but smaller than the primary stem leaves; cyathial peduncles 2–5 mm long. **Involucres** turbinate or cupuliform, 1.4–1.5 mm long, 1.5–1.8 mm across; lobes 5, narrow-triangular to broad-triangular, 0.5–0.6 mm long, margin entire, fimbriate or laciniate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-elliptic or orbicular in outline, 0.3–0.4 mm long, 0.5–0.6 mm wide, pale green; gland appendages present but inconspicuous, spreading radially, transverse-linear, to 0.1 mm long, 0.5–0.6 mm wide, pink or white, glabrous, margin entire; bracteoles 1.5–1.9 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into numerous linear glabrous or hirsute segments. **Staminate flowers** 5–20 per cyathium; pedicels 1–2 mm long; staminal filaments 0.5–0.7 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, ascending, spreading distally, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices dorsiventrally flattened. **Capsules** exserted from involucre on pedicel to 6 mm long, very broad-ovate or transversely broad-elliptic in lateral view, 2.3–2.8 mm long, 2.8–3.8 mm across, shallowly or deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** very broad-elliptic or very broad-ovate in outline, 1.5–1.7 mm long, 1.2–1.5 mm tangentially, 1.3–1.4 mm radially, trigonal or suborbicular in cross section; dorsal and ventral faces convex, smooth; exotesta thin, of even thickness over surface, white or pale brown, microreticulate; not becoming mucilaginous when moistened; endotesta brown. **Fig. 27G.**

***Additional selected specimens examined*: Queensland.** Cook District: Kerr Island, Torres Strait, Jan 2007, *Waterhouse BMW7498* (BRI); Deliverance Island, Apr 1996, *Waterhouse BMW3797* (BRI); Ida Point, *c.* 4 km SE of Cape York, Oct 1965, *Smith 12524* (BRI); Muttee Head, Cape York, Mar 1990, *Forster PIF6433* (BRI); Muddy Bay, Cape York, Jun 1994, *Forster PIF15316 & Tucker* (BRI); Saunders Island, Nov 1973, *Stoddart 5073* (BRI); Bathurst Bay, Aug 1974, *Hyland 7403* (BRI); Howick Island, Oct 1973, *Stoddart 4857* (BRI); Coquet Island, Howick Group, Mar 1984, *Godwin s.n.* (BRI [AQ440547]); Sinclair Island, Aug 1973, *Stoddart 4190* (BRI, MEL); Eagle Island, Great Barrier Reef, Jan 1973, *Heatwole s.n.* (BRI [AQ202465]); Ingram Island, Jul 1973, *Stoddart 4045* (BRI, NSW); Lizard Island, Sep 1967, *Heatwole 68* (BRI); Eagle Island, Oct 1973, *Stoddart 4821* (BRI); Three Isles, Sep 1973, *Stoddart 4470* (BRI); 2 km N of settlement at Bramston Beach, 12 km E of Babinda, Apr 1975, *McDonald 1490 & Batianoff* (BRI); Mission Beach, Dec 1949, *Clemens s.n.* (BRI [AQ202454]). North Kennedy District: Edmund Kennedy N.P., near Cardwell, Dec 1991, *Bean 3874* (BRI); Hinchinbrook Island, W of Kirkville Hills, Aug 1970, *Everist 9657* (BRI); George Point, Hinchinbrook Island, Apr 1994, *Cumming 12773* (BRI).

***Distribution and habitat*:** *Euphorbia pallens* ranges from Sri Lanka through Malaysia, southern China to Australia and the southwestern Pacific Islands. In Australia, it occurs in coastal areas from Torres Strait south along the east coast of Cape York Peninsula to Hinchinbrook Island (**Map 38**). It grows on coastal sands on frontal beach dunes and coral cays.

***Phenology*:** Flowers and fruits have been collected throughout the year.

Notes**:** The name *Euphorbia atoto* G.Forst. (*Chamaesyce atoto* (G.Forst.) Croizat) has been previously applied to this species in Australia (Forster 1994; Forster & Halford 2010), as well as in south east Asia and the Pacific (Hurusawa 1954; Smith 1981; Lin *et al.* 1991). Smith (1981) selected a lectotype for the name *E. atoto* from material at Kew. Florence (1996) set forth an opposing view on the lectotypification of *E. atoto* on the grounds that the specimen selected was in serious conflict with the protologue and that there was another element available that was part of the original material and morphologically agreed with the description in the protologue (ICBN Art 9.17). Esser & Chayamarit (2001) have put forward the argument that “it is not obvious whether the discrepancy discussed by Florence in the inflorescence architecture justifies this decision”. We have examined microfiche, photographs and digital images of the relevant material collected by the Forsters which resides in a number of herbaria (P-Forst, BM, G, GEOT, UPS-THUNB) and we concur with Florence’s conclusions. As circumscribed by Florence (1996) *E. atoto* is endemic to Tahiti. Therefore, another name is required for the widespread seashore species. *Euphorbia pallens* Dillwyn seems to be the next available name.

Euphorbia pallens is smiliar to *E. litticola*, *E. obliqua* and *E. psammogeton*. For features distinguishing *E. pallens* from *E. litticola*, refer to the ‘Notes’ section under that relevant species. *Euphorbia pallens* can be distinguished from *E. obliqua* by having its cyathia arranged in terminal or axillary lax to congested dichasial cymes (compared with cyathia solitary in upper axils for *E. obliqua*) and generally larger leaves (24–35 × 11–22 mm as compared with 9–20 × 6–10 mm for *E. obliqua*). It differs from *E. psammogeton* by its smooth rather than rugulose seeds, and smaller gland appendages (up to 0.1 mm long as compared with 0.2–0.4 mm long for *E. obliqua*).

Hassall (1977) recorded a chromosome number *n* = 8 for two voucher collections that were identified as *E. atoto* at the time, (*RLS* [*R.L.Specht*] *7478*, Lizard Island; and *GLW* [*G.L.Webster*] *73118*, Currimine [Kurrimine] Beach, both from north Queensland). Unfortunately, we have been unable to locate the vouchers that were apparently lodged in BRI and cannot confirm that they are *E. pallens*.

39. Euphorbia papillata Halford & W.K.Harris, **species nova** arcte similis *E. ferdinandi* Baill. sed habitu robustiore seminibus latioribus 0.7–1 mm latis (ad vicem 0.5–0.7 mm latis), glandulae appendicibus majoribus 0.1–0.2 mm longis (ad vicem appendicibus aut absentibus aut usque 0.1 mm longis), floribus staminatis 5–10 in quoque cyathio (in vicem floribus paucioribus 3–5 in quoque cyathio) differt. *Euphorbia papillata* quondam saepe putabatur eadem *E. drummondii* Boiss. esse sed seminum superficiebus ± laevibus (ad vicem superficiebus 3–6 porcis transversis distinctis praeditis), foliorum fructuumque superficiebus papillosis (ad vicem superficiebus laevibus), glandulae appendicibus 0.1–0.2 mm longis (ad vicem appendicibus usque 0.1 mm longis) distinguenda. **Typus:** Northern Territory. Georgina Station, 8 km NW of No. 14 Bore, 22 September 1992, *P.K.Latz 12754* (holo: BRI; iso: MEL, NT).

Monoecious, herbaceous perennial to 25 cm high, many stems arising from woody taproot crown, the whole plant glabrous. **Stems** prostrate or ascending to erect, much branched, papillose or smooth, often longitudinally ridged. **Interpetiolar stipules** subulate or narrow-triangular, 0.8–1.6 mm long, bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.3–0.7 mm long, smooth or papillose; blade obovate, oblong-obovate or narrow-oblong, 4–11 mm long, 2–5.5 mm wide, 1.6–3.1 times longer than wide; adaxial surface dark green or blue-green, papillose; abaxial surface blue-green but paler than adaxial surface, papillose; base asymmetric with one side cordate, the other cuneate or obtuse; margin serrulate distally; apex rounded or mucronate. **Cyathia** solitary at the nodes, often gathered together on short leafy lateral branchlets with subtending leaves usually slightly smaller than primary stem leaves; peduncles 0.3–0.6 mm long, papillose. **Involucres** campanulate or turbinate, 0.7–1.1 mm long, 0.8–1.4 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin entire or fimbriate; glands 4, shortly stipitate, cupuliform, with distinct central pit and thickened rim, transverse-oblong or transverse-elliptic in outline, 0.15–0.3 mm long, 0.25–0.4 mm wide, pink to red or pale green; gland appendages conspicuous, spreading radially, transverse-oblong, transverse-linear or reniform, 0.1–0.2 mm long, 0.5–0.7 mm wide, pink or white, glabrous, margin entire or shallowly lobed; bracteoles obovate, *c.* 1 mm long, divided into numerous subulate hirsute segments. **Staminte flowers** 5–10 per cyathium; pedicels 0.9–1.1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.1–0.4 mm long, spreading, ascending to erect, smooth or papillose, glabrous, each entire or bifid for *c.* 1/2 of their length, the apices stout terete. **Capsules** exserted from involucre on pedicel to 2 mm long; broad-elliptic in lateral view, 1.9–2.3 mm long, 1.6–2.4 mm across, shallowly 3-lobate with keels obtuse or acute, papillose, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1.3–1.6 mm long, 0.7–1 mm tangentially, 0.6–1 mm radially, tetraquetrous in cross section; dorsal faces ± planar, smooth or with faint narrow medial longitudinal ridge; ventral faces planar or concave, smooth; exotesta thin, of even thickness over surface, grey-white, microreticulate or microgranulate, becoming mucilaginous when moistened; endotesta pale brown to red brown.

Distribution and habitat: *Euphorbia papillata* is widespread in southern NT and western Qld, extending into northern SA and north-western NSW, but absent from the Simpson, Sturt Stony and Strzelecki Deserts.

Etymology: The specific epithet is from Latin *papillatus*, having papillae, in reference to the papillate surface of the capsules, leaves and sometimes the young branchlets of this species.

Notes: *Euphorbia papillata* closely resembles *E. ferdinandi* but differs from that by its more robust habit, broader seeds (0.7–1 mm versus 0.5–0.7 mm for *E. ferdinandi*), larger gland appendages (0.1–0.2 mm long versus gland appendages absent or up to 0.1 mm long for *E. ferdinandi*), and more staminate flowers per cyathium (5–10 versus 3–5 for *E. ferdinandi*).

Euphorbia papillata was previously often identified as *E. drummondii* but it is distinguished from that species by its ± smooth seed surfaces (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*), papillose surfaces on leaves and fruits (versus smooth for *E. drummondii*), and larger gland appendages (0.1–0.2 mm long versus gland appendages up to 0.1 mm long for *E. drummondii*).

As accepted here, *E. papillata* is very variable in leaf size and stem texture. Two varieties are recognised which can be distinguished by the following key.

Key to varieties of *Euphorbia papillata*

Stems papillose . . . . **39a. E. papillata** var. **papillata**
Stems ± smooth, lacking papillae. . . . . **39b. E. papillata** var. **laevicaulis**

39a. Euphorbia papillata var. papillata

Chamaesyce sp. (Pathungra A.Gunness AG2118); Forster & Halford (2010: 65).

Stems papillose. **Leaves**: petiole 0.3–0.7 mm long, papillose; blade obovate or oblong-obovate, 4–10 mm long, 2–5.5 mm wide, 1.6–2.3 times longer than wide. **Involucres** campanulate or turbinate, 0.9–1.1 mm long, 1–1.4 mm across; lobes 0.4–0.5 mm long, margin fimbriate. *n* = 11. **Figs 15, 27H.**

Additional selected specimens examined: **Northern Territory.** Phillip Creek Station, May 1993, *Egan 2287* (BRI); Alexandria Station, 5 km NE [of] Buchanan Creek, Nov 1986, *Henshall 4131* (DNA, NT); 35.5 miles [*c.* 57 km] NNW [of] Wauchope township, Aug 1956, *Lazarides 5849* (BRI, DNA); Wakaya Desert, May 1993, *Latz 13086* (DNA, MEL); 40 km N [of] Plenty Highway on Sandover Highway, Apr 1988, *Kimbel 68* (DNA, NT); 12 miles [*c.* 19 km] W of Stuart Highway, along Yuendumu Road, Apr 1967, *Maconochie 62* (AD, DNA, MEL); Illamurta Springs area; 7.5 km west, Aug 1988, *Barritt 323* (DNA); Uluru (Ayers Rock – Mt Olga) N.P.; on the Docker River road, 53.6 km WNW

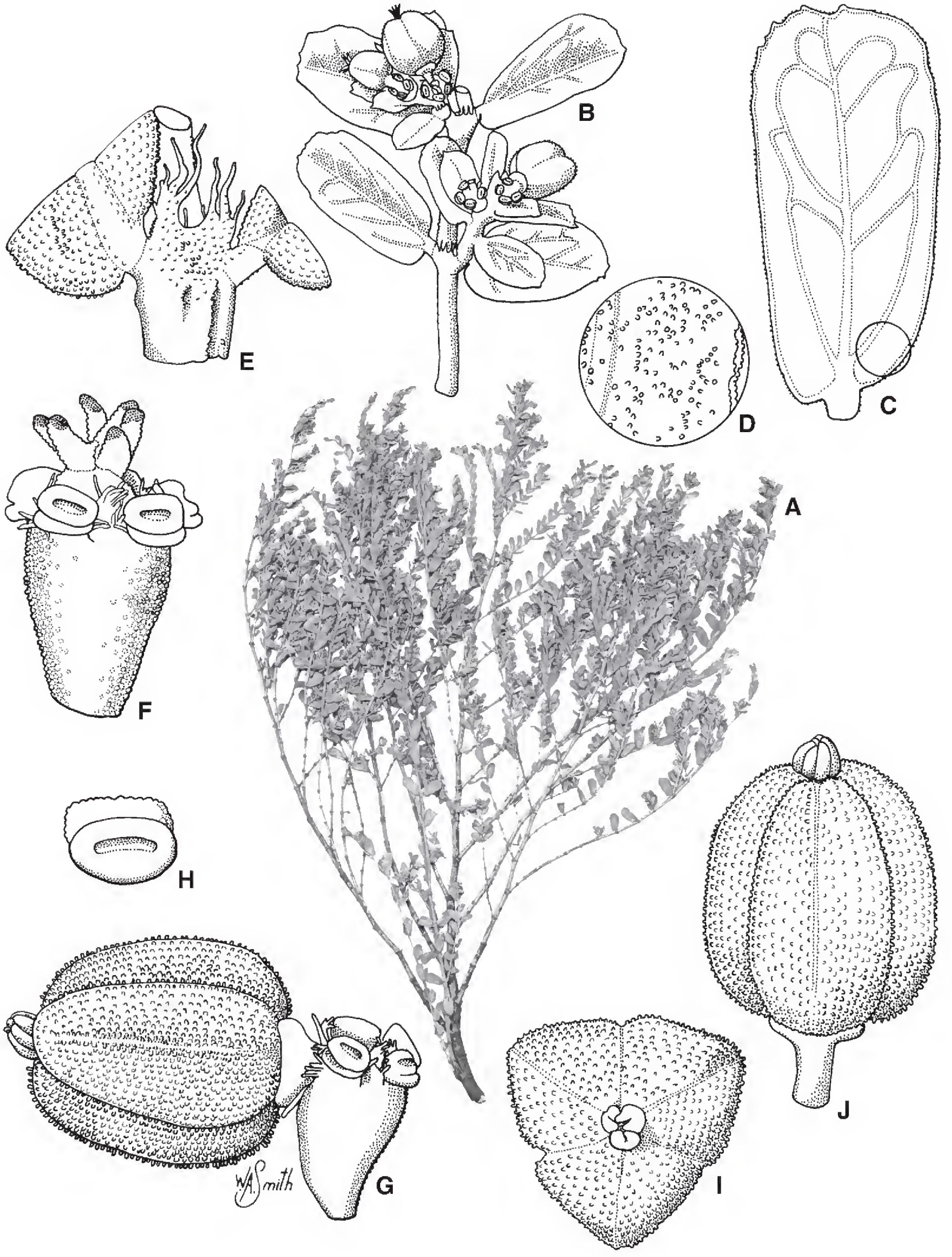

Fig. 15. ***Euphorbia papillata*** *var.* ***papillata***. A. habit ×0.6. B. branchlet with cyathia ×4. C. leaf ×8. D. indumentum on upper leaf surface ×32. E. stipules ×24. F. cyathia with female flower ×24. G. capsule with cyathia ×16. H. cyathial gland with appendage, adaxial view ×32. I. capsule, top view ×16. J. capsule, lateral view ×16. A, C & D from *Latz 12754* (NT); B, E–J from *Halford Q8597 & Thomas* (BRI). Del. W.Smith.

of the Ranger Station, Aug 1988, *Lazarides & Palmer 539* (MEL). **Queensland.** Burke District: 1 km W of Torrens Creek (township) along Flinders Highway, towards Hughenden, Apr 2006, *Halford Q9020 & Batianoff* (BRI). Gregory North District: 31 km from Winton, Bladensburg N.P., Sep 2005, *Halford Q8597 & Thomas* (BRI); 60 km S of Winton on road to Opalton, Sep 2005, *Halford Q8600 & Thomas* (BRI); Jundah – Winton road, 38 km S of Mayne River crossing, May 2004, *Bean 22495* (BRI). Warrego District: *c.* 13 km E of Quilpie, near junction of Adavale Road and Quilpie – Cheepie Road, Jun 2002, *Pollock ABP1301 & Walsh* (BRI). Gregory South District: 81 km by road NW of Thylungra and 197 km NW of Quilpie on the Windorah Road, Mar 2001, *Thomas 1948 & Fechner* (BRI). **South Australia.** Everard Ranges, Wildcat Bore, Sep 1963, *Eichler 17467* (AD); near Marla, Oct 1998, *Bates 51375* (AD); *c.* 25 km W of Tallaringa Well, May 1967, *Lothian 3841* (AD). **New South Wales.** 4 km W of Weebah Gate, NSW – Qld border, Nov 1976, *Pickard 3305* (NSW).

Distribution and habitat: *Euphorbia papillata* var. *papillata* is widespread in southern NT and western Qld, extending into northern SA and north-western NSW, but absent from the Simpson, Sturt Stony and Strzelecki Deserts (**Map 39a**). It grows in mulga woodland, eucalypt open woodland, open shrubland or tussock grassland communities on red sandy to loam soils on plains, low lateritic or limestone rises; also rarely recorded on black clay soils in Mitchell grassland or open woodland communities.

Phenology: Flowers and fruits have been collected throughout the year, particularly from March to June.

39b. Euphorbia papillata var. **laevicaulis** Halford & W.K.Harris, **varietas nova** ab *E. papillata* var. *papillata* caulibus ± laevibus papillis carentibus differt. **Typus:** Queensland. Mitchell District: Moorrinya National Park, 7 May 2006, *E.J.Thompson & G.W.Wilson TAN551* (holo: BRI).

Stems smooth. **Leaves**: petiole 0.5–0.7 mm long, smooth; blade narrow-oblong, 6–11 mm long, 2–3.6 mm wide, 2.2–3.1 times longer than wide. **Involucres** turbinate, 0.7–0.8 mm long, *c.* 0.8 mm across; lobes 0.3–0.4 mm long, margin entire or fimbriate. **Fig. 27I.**

Additional selected specimens examined: **Northern Territory.** 29 km S [of] Renner Springs, Jun 1977, *Parker 942* (BRI). **Queensland.** Burke District: 26 km N of Burke and Wills Roadhouse, Mar 2003, *McDonald KRM1332* (BRI); Glengalla, 63 miles [*c.* 101 km] N of Maxwelton, Jun 1947, *Everist 3035* (BRI); 1 km W of Torrens Creek (township) along Flinders Highway, towards Hughenden, Apr 2006, *Halford Q9021 & Batianoff* (BRI). North Kennedy District: Flinders Highway, 36 km E of Torrens Creek, Jul 2000, *Bean 16764* (BRI); 20 km from Charters Towers, towards Clermont, Apr 2002, *Bean 18961* (BRI, MEL). South Kennedy District: 6 km N of Ulcanban homestead, Mar 2002, *Turpin GPT740 & Thompson* (BRI). Mitchell District: 72 km S of Prairie on stock route, 1 km E of Holmleigh homestead, Mar 2004, *Thompson TAN153 & Cumming* (BRI); 32 km SSE of Prairie on Stock Route 503 bordering Ashton Station, Mar 2004, *Thompson TAN132 & Cumming* (BRI); Corinda Station, 10 km NE of Corinda homestead, May 2006, *Thompson TAN264 & Wilson* (BRI); Corinda Station, 16.1 km N of Corinda homestead, May 2006, *Thompson TAN333 & Wilson* (BRI); Moorinya N.P., *c.* 100 km S of Torrens Creek, Apr 2005, *Booth 3707 & Thompson* (BRI); Corinda, 100 km N of Aramac, Mar 2004, *Cumming 22475 & Thompson* (BRI); 50 km from Longreach, towards Winton, May 2004, *Bean 22594* (BRI).

Distribution and habitat: *Euphorbia papillata* var. *laevicaulis* extends from Cloncurry eastward to Charters Towers and south to near Longreach, Qld; with a disjunct occurrence near Renner Springs, NT (**Map 39b**). It is recorded growing in a variety of habitats: tussock/hummock grassland, *Eremophila mitchellii* Benth. low open woodland, mulga woodland and eucalypt woodland/open forest, on mostly undulating plains. The soils vary from sands to clays.

Phenology: Flowers and fruits have been collected from January, March to July and October.

Notes: *Euphorbia papillata* var. *laevicaulis* differs from *E. papillata* var. *papillata* by its ± smooth stems that lack papillae.

Etymology: The varietal epithet is from Latin *laevis*, smooth, and *caulis*, stem, in reference to the more or less smooth surface of the stems of this variety.

40. Euphorbia papillifolia Halford & W.K.Harris, **species nova** quoad formam sculturamque seminum superficierum similis *E. ophioliticae* (P.I.Forst.) Y.Yang differt autem foliis oblongis ovatisve 1.5–2.8 plo longioribus quam latioribus (ad vicem foliis ellipticis usque late ellipticus 1–1.5 plo longioribus quam latioribus) glandis minoribus 0.1–0.4 × 0.3–0.8 mm (ad vicem glandulis 0.4–0.5 × 0.6–1 mm) seminibus minoribus 1.3–1.6 × 0.7–1 × 0.8–1 mm (ad vicem seminibus 1.7–1.8 × 1–1.1 × 1–1.1 mm) plerumque stipulis longioribus 0.5–1.6 mm longis (ad vicem stipulis 0.2–0.6 mm longis). *Euphorbia papillifolia* crescit in solis argillis repantis saepe a basalto orituris quoniam *E. ophiolitica* in solis a saxis serpentinis orituris. **Typus:** Queensland. Port Curtis District: South Kariboe Creek crossing, Burnett Highway, between Biloela and Monto, 19 March 2010, *D.Halford Q9771 & G.P.Guymer* (holo: BRI, iso: MEL, NSW, *distribuendi*).

Monoecious or dioecious, herbaceous perennial to 10 cm high, few to many stems arising from woody rootstock. **Stems** prostrate or decumbent, sparingly to much branched, often longitudinally ridged, glabrous (rarely with a moderately dense indumentum, *Allison TH5034* [BRI]); hairs spreading, straight, 0.1–0.4 mm long, white. **Interpetiolar stipules** subulate or narrow-triangular, 0.5–1.6 mm long, bifid or deeply bipartite, glabrous; margin entire, laciniate or sometimes fimbriate. **Leaves**: petiole 0.6–1.1 mm long, smooth, glabrous; blade oblong or ovate, 7–11 mm long, 2.5–9 mm wide, 1.8–2.8 times longer than wide; adaxial surface blue-green sometimes with reddish tinge along margin; minutely papillose (visible at 40× mag.), glabrous (rarely with a moderately dense indumentum consisting of spreading, straight hairs to 0.4 mm long, abaxial surface pale grey to white; minutely papillose (visible at 40× mag.), glabrous or with indumentum as of adaxial surface; base asymmetric with one side cordate, the other cuneate or obtuse to rounded; margin serrulate or sparingly minutely toothed sometimes only distally (rarely entire); apex acute to obtuse or rounded. **Cyathia** solitary at the nodes, often gathered together on short leafy lateral branches; peduncles 0.6–1.3(2.3) mm long, smooth, glabrous. **Involucres** turbinate or cupuliform, 0.6–1.5 mm long, 0.6–1.8 mm across; lobes 5 or 6, triangular, 0.2–0.4 mm long, margin laciniate or fimbriate; glands 4–6, stipitate, patelliform, planar or concave, transverse-oblong or reniform in outline, 0.1–0.4 mm long, 0.3–0.8 mm wide, pink, red or yellowish green; gland appendages conspicuous, spreading radially, transverse-oblong, broad-obovate to very broad-obovate, obdeltoid or reniform, 0.1–0.9 mm long, 0.9–1.4 mm wide, pink or white, glabrous, margin entire, erose or shallowly lobed; bracteoles 0.5–0.6 mm long, adnate for *c.* 1/2 of their length to involucre, free portion divided into few linear hirsute segments. **Staminate flowers** 1–30 per cyathium; pedicels 0.8–1.3 mm long; staminal filaments 0.1–0.3 mm long. **Pistillate flowers**: styles 0.3–0.8 mm long, connate at the base into a column for *c.* 1/6 of their length, spreading, minutely papillose or smooth, pubescent or glabrous, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3.5 mm long, broad-elliptic or transversely broad-elliptic in lateral view, 1.5–2.1 mm long, 1.7–2.2 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate to broad-ovate in outline, 1.3–1.6 mm long, 0.7–1 mm tangentially, 0.8–1 mm radially, tetraquetrous or tetragonous in cross section; dorsal faces convex; ventral faces planar to concave; all faces smooth, faintly undulate or with faint to distinct narrow rounded irregular ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown.

***Distribution and habitat*:** *Euphorbia papillifolia* is widespread in eastern Australia from near Mount Surprise, north-eastern Qld, south to the Bathurst district, NSW.

***Etymology*:** The specific epithet is from Latin *papilliatus*, having papillae, and *-folius*, leaved, in reference to the papillose leaf surface of this species.

***Notes*:** *Euphorbia papillifolia* is similar to *E. ophiolitica* in seed shape and seed surface texture. It differs in having oblong or ovate leaves 1.5–2.8 times longer than wide (versus elliptic to broadly elliptic, 1–1.5 times longer than wide for *E. ophiolitica*), smaller glands (0.1–0.4 × 0.3–0.8 mm versus 0.4–0.5 × 0.6–1 mm), smaller seed dimensions (1.3–1.6 × 0.7–1 × 0.8–1 mm versus 1.7–1.8 × 1–1.1 × 1–1.1 mm) and generally longer stipules (0.5–1.6 mm long versus 0.2–0.6 mm long). They also differ in habitat with *E. papillifolia* occurring on cracking clay soils often derived from basalt substrate while *E. ophiolitica* is restricted to soils derived from serpentinite rocks.

As accepted here, *E. papillifolia* varies in breeding system, the number of gland per cyathia and length of gland appendages. This variation is considered sufficient to warrant formal recognition of two varieties within this species which can be distinguished using the following key.

Key to varieties of *Euphorbia papillifolia*

Plants monoecious; gland appendages 0.1–0.4 mm long; glands 4 per cyathia; staminate flowers per cyathia <15; styles 0.3–0.5 mm long . . . . **40a. E. papillifolia** var. **papillifolia**

Plants dioecious (rarely monoecious); gland appendages 0.4–0.9 mm long; glands 4–6 per cyathia; staminate flowers per cyathia ≥15, styles 0.5–0.8 mm long . . . . **40b. E. papillifolia** var. **polyandra**

40a. Euphorbia papillifolia var. papillifolia

Monoecious, herbaceous perennials. **Stems** prostrate, glabrous or rarely with a moderately dense indumentum. **Involucres** turbinate, 0.6–1 mm long, 0.6–1.1 mm across; lobes 5, triangular, 0.2–0.3 mm long; glands 4, 0.1–0.3 mm long, 0.3–0.5 mm wide; gland appendages 0.1–0.4 mm long, 0.3–0.9 mm wide. **Staminate flowers** 1–10 per cyathium. **Female flowers** with styles 0.3–0.5 mm long. **Figs 16, 27J**.

***Additional selected specimens examined*: Queensland.** COOK DISTRICT: Undara N.P., NW of Tobacco Spring, Dec 2006, *McDonald KRM6036* (BRI). BURKE DISTRICT: *c.* 92 km N of Hughenden, Apr 1998, *Thompson HUG531 et al.* (BRI). NORTH KENNEDY DISTRICT: Mt Fox, Dec 1949, *Clemens s.n.* (BRI [AQ202423]); several kms SE of turn off to Ingham, Jun 1999, *Addicott 113* (BRI); Burdekin River, 40 km N of Charters Towers, *c.* 1 km S of Keelbottom Mountain, Jul 1981, *Sharpe 2894* (BRI); N of Bowen, May 1997, *Calvert & Lockyers 1* (BRI); Millview, 15 km N of Charters Towers, Jul 2006, *Hooker NH675* (BRI). LEICHHARDT DISTRICT: 29 km S of Springsure, Mar 1995, *Fensham 2607* (BRI); 12 km SE of Rolleston, Jan 1996, *Fensham 2422* (BRI). PORT CURTIS DISTRICT: Surfus Hill, E of Marlborough Creek, Nov 1997, *McCabe C2* (BRI); Glen Geddes, near Rockhampton, Jun 1965, *Beauglehole ACB3567* (MEL, NSW); South Kariboe Creek, SE of Biloela, Jan 1996, *Bean 9637* (BRI). BURNETT DISTRICT: *c.* 8 km NW of 'Rawbelle', W of Monto, Jun 1996, *Bean 10379* (BRI). WARREGO DISTRICT: junction of Landsborough & Mitchell Highways, 5.5 km S of Augathella, Oct 2011, *Halford QM625* (BRI). MARANOA DISTRICT: The Lamen, ESE of Roma, Jan 1998, *Bean 12989* (BRI).

***Distribution and habitat*:** *Euphorbia papillifolia* var. *papillifolia* is widespread in central east Qld from Undara N.P., east to Mt Fox (west of Ingham) and south to Roma and Monto (**Map 40a**). It inhabits *Dichanthium* spp. grassland or eucalypt/*Acacia* woodland on plains or gently undulating country. The soils are dark brown to black cracking clays often derived from basalt substrates.

***Phenology*:** Flowers and fruits have been collected throughout the year.

40b. Euphorbia papillifolia var. polyandra Halford & W.K.Harris, varietas nova

a varietate typica plerumque glandulae appendicibus majoribus 0.4–0.9 × 0.9–1.4 mm (ad vicem appendicibus 0.1–0.4 × 0.3–0.9 mm), staminibus pluribus in quoque cyathio (15–30 non 1–7), stylis longioribus 0.5–0.7 mm longis (ad vicem stylis 0.3–0.5 mm longis), interdum seminibus majoribus 1.3–1.6 × 0.9–1 × 0.9–1 mm (ad vicem seminibus 1.3–1.4 × 0.7–0.9 × 0.8–0.9 mm) differt. **Typus:** New South Wales. eastern bank of Lake Inverell, *c.* 4 km SE of Inverell, 11 December 2002, *L.M.Copeland 3483* (holo: BRI, according to label information on the holotype sheet there are duplicates (isotypes) lodged at CANB, L, MEL, NE, NSW – all *n.v.*).

Chamaesyce sp. A.; James & Harden (1990: 428).

Dioecious (rarely monoecious), herbaceous perennials. **Stems** prostrate or decumbent, glabrous. **Involucres** turbinate or cupuliform, 0.9–1.5 mm long, 0.8–1.8 mm across; lobes 5–6, triangular, 0.3–0.4 mm long; glands 4–6, 0.2–0.3 mm long, 0.5–0.8 mm wide;

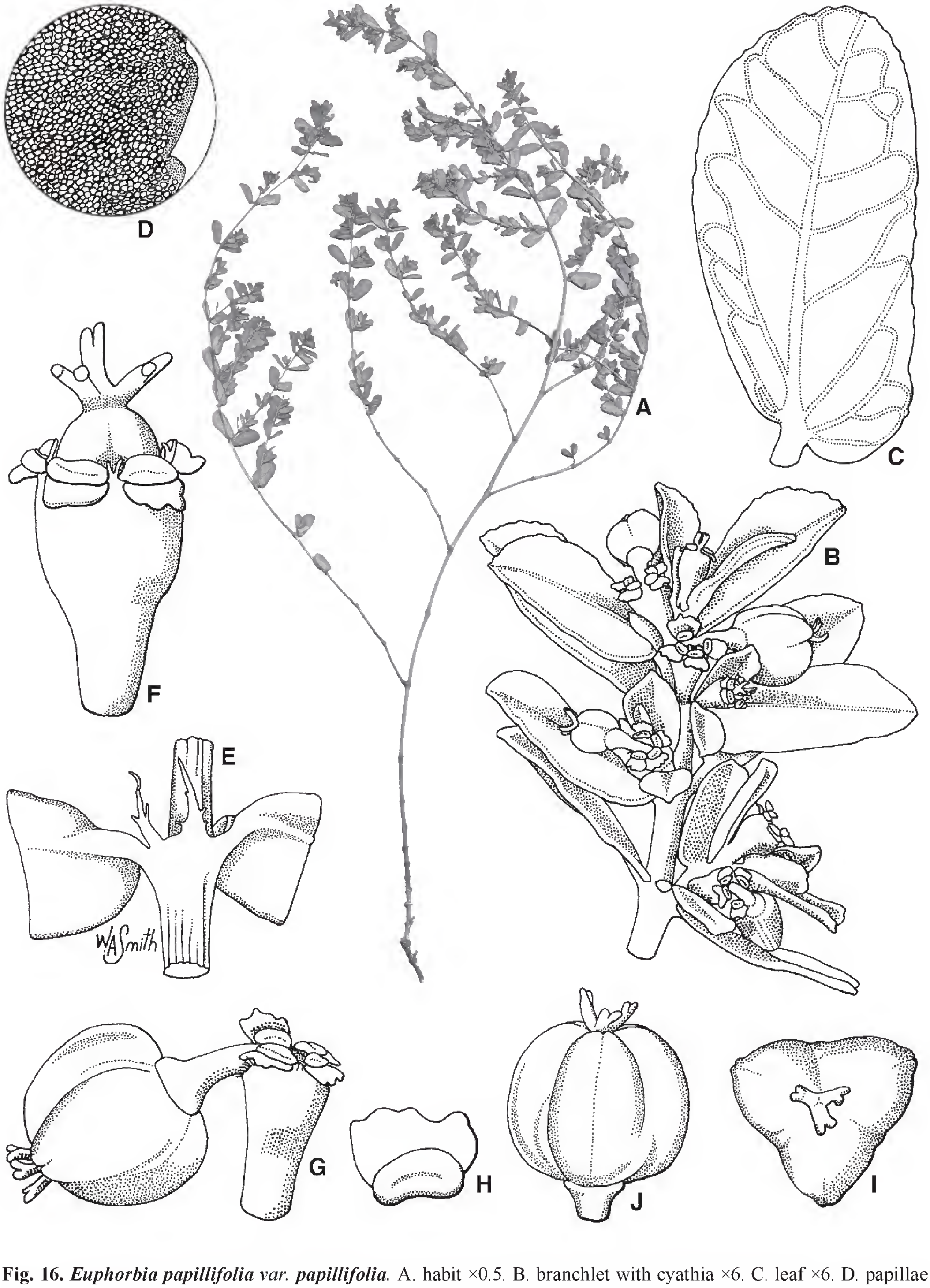

Fig. 16. ***Euphorbia papillifolia*** *var.* ***papillifolia.*** A. habit ×0.5. B. branchlet with cyathia ×6. C. leaf ×6. D. papillae on lower leaf surface ×32. E. stipules ×24. F. cyathia with female flower ×24. G. cyathia with capsule ×12. H. cyathial gland with appendage, adaxial view ×32. I. capsule, top view ×12. J. capsule, lateral view ×12. All from *Halford Q9771 & Guymer* (BRI). Del. W.Smith.

gland appendages (0.1)0.4–0.9 mm long, 0.9–1.4 mm wide. **Staminate flowers** 15–30 per cyathium. **Pistillate flowers** with styles 0.5–0.7 mm long. $n = 11$.

***Additional selected specimens examined*: Queensland.** LEICHHARDT DISTRICT: Warren State Farm, Mar 1920, *Francis s.n.* (BRI [AQ202944]); Barfield, Jan 1945, *Scarlett S228* (BRI); 1.2 km along Lyndley Lane, N of Jimbour, Nov 1997, *Bean 12531* (BRI). **New South Wales.** Mt Russell, near Inverell, Dec 1915, *Breakwell s.n.* (NSW 614327); 9.3 km NE of Inverell on Nullamanna Road, May 1985, *Wilson 6178* (NSW); Inverell, Apr 1913, *Boorman s.n.* (NSW 612144); Sinclair Lookout, Waterloo Range, 14.4 km W of Glen Innes, Mar 1987, *Coveny 12489 et al.* (NSW); 40 km ENE of Narrabri, Sep 1976, *Hassall 7669* (BRI); entrance to Mt Kaputar N.P. on Dawsons Spring Road, 28 km ENE of Narrabri, Nov 1976, *Coveny 8893 & Roy* (NSW); Binnaway Road, 5 miles [*c.* 8 km] SSE of Coonabarabran, Jan 1962, *Salasoo 2313* (NSW); east facing slope to north of Dulegal Arboretum, Chaffey Dam, Feb 1993, *Hosking 688* (MEL); Kelso, Mar 1933, *McKie s.n.* (NSW 614324).

***Distribution and habitat*:** *Euphorbia papillifolia* var. *polyandra* occurs from Springsure, Qld, south to the Bathurst district, NSW (**Map 40b**). It grows in grassy *Eucalyptus* woodland or *Themeda*/*Dichanthium* grassland on plains or undulating to hilly terrain. The soils are mostly red clay loams to black clays, rarely sandy. It is also recorded as a weed of cultivation.

***Phenology*:** Flowers and fruits have been collected throughout the year.

***Notes*:** *Euphorbia papillifolia* var. *polyandra* differs from the type variety in having generally larger gland appendages (0.4–0.9 × 0.9–1.4 mm versus 0.1–0.4 × 0.3–0.9 mm), more stamens per cyathia (15–30 versus 1–7), longer styles (0.5–0.7 mm long versus 0.3–0.5 mm long) and generally larger seeds (1.3–1.6 × 0.9–1 × 0.9–1 mm versus 1.3–1.4 × 0.7–0.9 × 0.8–0.9 mm).

Bentham (1873) cited a Dr Beckler collection from Warwick, Qld (MEL 68198) under *E. alsiniflora* with the comment that it appears to be the same species. The Beckler collection is here identified as *E. papillifolia* var. *polyandra*.

Hassall (1977) proposed the name *E. drummondii* subsp. *bleckeri* for this taxon but this name was never validly published.

***Etymology*:** The varietal epithet is from Greek *polys*, many, and *andrus*, man (stamen), in reference to the many more stamens present per cyathia in this variety compared with the type variety.

41. Euphorbia petala Ewart & L.R.Kerr, *Proc. Roy. Soc. Victoria* 39: 1, fig. 1 (1926); *Chamaesyce petala* (Ewart & L.R.Kerr) P.I.Forst. & R.J.F.Hend., *Novon* 5: 323 (1995). **Type:** [Northern Territory.] Wycliffe Well, June 1924, [*A.J. Ewart s.n.*] (lecto [here designated]: MEL 1560387; isolecto: MEL 503409).

***Illustration*:** Ewart & Kerr (1926: 2, fig 1).

Monoecious, herbaceous perennial, few to many stems arising from woody taproot, the whole plant glabrous. **Stems** prostrate, much branched, smooth. **Interpetiolar stipules** narrow-triangular to subulate, 0.6–1.5 mm long, bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.5–0.8 mm long, smooth; blade oblong, obovate or elliptic, 6–11 mm long, 3–7 mm wide, 1.5–2.8 times longer than wide; adaxial surface pale blue-green or dull light green, smooth; abaxial surface similar to but paler than adaxial surface; base asymmetric with one side auriculate to cordate, the other shallowly cordate to rounded; margin serrulate or sparingly minutely toothed; apex rounded to shallowly retuse. **Cyathia** solitary at the nodes, often gathered together on short leafy lateral branchlets with subtending leaves usually slightly smaller than primary stem leaves; peduncles 0.2–0.8(1.2) mm long, smooth. **Involucres** campanulate or turbinate, 1.1–1.5 mm long, 1–1.2 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin entire or fimbriate; glands 4, stipitate, patelliform, concave, or cupuliform with central tangential pit, transverse-oblong in outline, 0.1–0.5 mm long, 0.4–0.5 mm wide, pink or red; gland appendages conspicuous, spreading radially, obdeltoid, 0.3–1.3 mm long, 1.1–2 mm wide, pink or white, glabrous, margin irregularly toothed or shallowly lobed distally; bracteoles 0.7–0.8 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into few to numerous, subulate glabrous segments. **Staminate flowers** 7–10 per cyathium; pedicels 0.9–1.3 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.5 mm long, spreading, smooth, glabrous, each entire or scarcely bifid, the apices terete. **Capsules** exserted from involucre on pedicel to 2.5 mm long, broad to very broad-ovate in lateral view, 1.7–1.8 mm long, 1.7–2 mm across, shallowly 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1–1.2 mm long, 0.6–0.7 mm tangentially, 0.6–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar or convex; ventral faces concave; all faces with faint narrow irregular ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown or red-brown. **Fig. 27K.**

***Additional selected specimens examined*: Northern Territory.** Panu Panu Soakage, near Lake Surprise, Aug 1991, *Latz 12135* (DNA, MEL); 50 km W of Newcastle Waters homestead, Feb 1989, *Thomson 3187* (DNA); 60 km NE [of] Bob Well, Lander River, Jul 1989, *Latz 11556* (MEL); 11.4 km N of Elliot on Stuart Highway, Apr 1983, *Barker 194* (AD, NSW); 32 km S [of] Elliott on Stuart Highway, Mar 1991, *Thomson 3450* (DNA); 8 km N [of] Renner Springs, Stuart Highway, Feb 1988, *Thomson 2240* (DNA); 40 km ESE [of] Barrow Creek, May 1996, *Albrecht 7563 & Latz* (DNA); Elkedra Station, 7 km NW of homestead on road to Hatches Creek via jump-up, Aug 1979, *Morton 210* (DNA, MEL); Little Lagoon, Groote Eylandt, Apr 1948, *Specht 220* (AD, BRI, MEL, NSW); Calvert River mouth, Jun 1987, *Thomson 1894* (DNA); Old Highland Plains, Jul 1971, *Latz 1741* (DNA). **Queensland**. BURKE DISTRICT: Nicholson River crossing, 3 km E of Doomadgee, Jun 1991, *Halford Q607* (BRI); Musselbrook Creek Gorge, 27.6 km (by road) NE of Musselbrook Mining Camp, 175 km N of Camooweal – Lawn Hill N.P., Apr 1995, *Johnson MRS598 & Thomas* (BRI); 88.5 km along Richmond Road, 0.7 km S of Prospect Station turnoff; Esmeralda Station, Apr 2007, *McDonald KRM6433* (BRI); Paradise Swamp, *c.* 10 km NW of Burke & Wills Roadhouse and N of the Burketown Development Road, Feb 2006, *Fox IDF3904 & Wilson* (BRI); Richmond – Croydon Road, 109.0 km from Richmond, Jul 1998, *Bean 13409* (BRI); Bunda Bunda, NE of Julia Creek, Apr 1999, *Fensham 3759* (BRI). NORTH KENNEDY DISTRICT: 29 km S of Yarrowmere homestead on track to Bowie homestead, Whistling Duck Creek, Apr 2006, *Halford Q9035a & Batianoff* (BRI). SOUTH KENNEDY DISTRICT: *c.* 18 km of Moonoomoo Station on road to Yarrowmere Station from Bowie Station, Oct 1983, *Henderson H2804 et al.* (BRI).

***Distribution and habitat*:** *Euphorbia petala* occurs from Groote Eylandt, Newcastle Waters and Lake Surprise in NT, eastward to Charter Towers and near Aramac, north Qld (**Map 41**). It grows in *Triodia* grassland or open eucalypt/melaleuca woodland/open forest on sand plains, sandstone rises, inland sand dunes or sandy river terraces. It has also been recorded in low monsoon forest. The soils are sandy to sandy loam.

***Phenology*:** Flowers and fruits have been collected from February to October.

***Typification*:** There are two sheets [1560387 & 503409] at MEL collected by Ewart at Wycliffe Well in June 1924 and annotated with the name *E. petala* that qualify as syntypes of *E. petala*. The sheet MEL 1560387 is the more ample specimen and is selected here as lectotype of the name.

***Notes*:** *Euphorbia petala* is similar to *E. albrechtii*, *E. cinerea* and *E. ophiolitica*. For features distinguishing *E. petala* from *E. albrechtii* and *E. cinerea*, refer to the 'Notes' section under *E. albrechtii*.

42. Euphorbia philochalix Halford & W.K.Harris, **species nova** quoad habitum generali et formam seminis capsulaeque similis *E. verrucitestae* Halford & W.K.Harris sed ab ea glandulae appendicibus longioribus 0.1–0.3 mm longis (ad vicem appendicibus c. 0.5 mm longis), seminibus 0.9–1.1 mm longis interdum brevibus (ad vicem seminibus 1.1–1.2(1.3) mm longis), seminum superficiebus porcis prominentibus angustis praeditis irregularis (ad vicem superficiebus verrucosis) distinguenda. *Euphorbia philochalix* quondam putabatur eadem *E. drummondii* Boiss. esse sed seminum superficiebus irregulariter porcatis (ad vicem superficiebus porcis 3–6 distinctis transversis), capsulis latis usque perlatis 1.3–1.5(1.8) × 1.5–1.8(2.1) mm plerumque minoribus (ad vicem capsulis 1.6–1.8 × 1.7–1.9 mm), seminibus late obovatis (ad vicem seminibus oblongo-ovatis), stylis bifidis 1/3–1/2 longitudinis (ad vicem stylis integris vel vix bifidis) differt. **Typus:** Western Australia. 37 km S of Denham, 24 May 1991, *B.G.Thomson 3515* (holo: DNA; iso: NT, according to label information on the holotype sheet there are duplicates (isotypes) lodged at PERTH *n.v.*, K *n.v.*).

Monoecious, annual to 15 cm high, many stems arising from slender taproot, the whole plant glabrous. **Stems** prostrate or ascending, much branched, smooth or often longitudinally ridged. **Interpetiolar stipules** narrow-triangular, 0.9–1.2 mm long, bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.1–1 mm long, smooth; blade obovate or elliptic, 4.3–6.7 mm long, 2.3–4.2 mm wide, 1.2–1.9 times longer than wide; adaxial and abaxial surfaces green sometimes with reddish tinge especially along margins, smooth or minutely papillose; base symmetric, obtuse to cuneate or asymmetrical with one side cordate, the other obtuse or rounded; margin entire or sparingly minutely toothed distally; apex retuse or rounded. **Cyathia** solitary at the nodes, peduncles 0.3–0.5 mm long. **Involucres** campanulate or turbinate, 0.8–1.1 mm long, 0.9–1.2 mm across; lobes 5, triangular, 0.4–0.6 mm long, margin entire or fimbriate; glands 4, stipitate, cupuliform, with shallow central pit and somewhat thickened rim, transverse-oblong in outline, 0.1–0.3 mm long, 0.2–0.5 mm wide, pink or red; gland appendages conspicuous, spreading radially, obdeltoid or oblong, 0.1–0.3 mm long, 0.5–0.7 mm wide, pink, glabrous, margin entire, crenulate or shallowly irregularly lobed; bracteoles 0.8–1.1 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into few subulate hirsute segments. **Staminate flowers** 5–10 per cyathium; pedicels 1–1.5 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.3–0.5 mm long, spreading or ascending, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices stout terete. **Capsules** exserted from involucre on pedicel to 2 mm long, broad to very broad-ovate in lateral view, 1.3–1.5 mm long, 1.6–1.8 mm across, shallowly 3-lobate with keels acute, smooth, glabrous; hypogynous disc entire. **Seeds** broad-ovate in outline, 0.9–1.1 mm long, 0.6–0.8 mm tangentially, 0.6–0.8 mm radially, tetraquetrous in cross section; dorsal and ventral faces concave, with prominent irregular rounded ridges; exotesta thin, of even thickness over surface, white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown. *n* = 11. **Figs 17, 27L.**

***Additional selected specimens examined*: Western Australia.** *c.* 8.5 km S of Useless Loop township and Trig Station, Shark Bay, Oct 1997, *Markey 1563* (PERTH); Salutation Island, Freycinet Estuary, Shark Bay, Sep 1989, *Alford 1316* (PERTH); 1 mile [*c.* 1.6 km] S of Useless Loop, Aug 1970, *Aplin 3386* (PERTH); Three Bay Island, Shark Bay, Sep 1989, *Alford 1285* (PERTH); Baudin Island, Freycinet Estuary, Shark Bay, Sep 1989, *Alford s.n.* (PERTH 4591437); 15 miles [*c.* 24 km] W of Wiluna, Aug 1973, *Hassall 73101* (BRI); Kalbarri N.P., Aug 1994, *Cranfield 9272* (PERTH); [Houtman] Abrolhos Islands, Nov 1897, *Helms s.n.* (PERTH 2436752, 2436817); Little Rat Island, Easter Group, Abrolhos Islands, Nov 1999, *Harvey s.n.* (PERTH 6228739); Sachse Property, Snake Soak, Sep 2002, *Davis WW76-35* (PERTH); *c.* 15 km SE of Bonnie Rock, Sep 2001, *Sage WW43-33 et al.* (PERTH); *c.* 18.2 km NNW of Mt Dimer, Hunt Range, Jaurdi Station, Jul 1995, *Gibson 3708 & Lyons* (PERTH); 50 miles [*c.* 80 km] N of Kalgoorlie, Aug 1973, *Hassall 73100* (BRI); 17 miles [*c.* 27 km] N of Kalgoorlie, Aug 1973, *Hassall 7398* (BRI)[mixed collection with *E. multifaria*]; near Broad Arrow, 38 km N of Kalgoorlie, Sep 1927, *Gardner & Blackall s.n.* (PERTH 2437201). **Northern Territory.** Old Curtain Springs homestead, SW Mt Connor, Sep 1986, *Thomson 1442* (DNA) [mixed collection with *E. porcata*].

***Distribution and habitat*:** *Euphorbia philochalix* occurs from Shark Bay and the Houtman Abrolhos Islands, east to near Kalgoorlie, WA, with a disjunct population near Mt Connor in southern NT (**Map 42**). It grows in low shrubland or low eucalypt open woodland communities on sand dunes, gentle undulating terrain or limestone rises. The soils are mostly brown to red sands or sandy clays, often over limestone.

***Phenology*:** Flowers and fruits have been collected from May to November.

***Notes*:** *Euphorbia philochalix* is similar to *E. verrucitesta* in its general habit, and seed and capsule shape. It may be distinguished from that species by its longer gland appendages (0.1–0.3 mm long versus *c.* 0.5 mm long for *E. verrucitesta*), generally shorter seeds (0.9–1.1 mm long versus 1.1–1.2(1.3) mm long for *E. verrucitesta*) and prominent narrow irregular ridged seed surfaces (versus irregular wart-like protuberances on the seed surface for *E. verrucitesta*).

Euphorbia philochalix has previously been identified as *E. drummondii*, but differs from that species in having prominent irregularly ridged seed surfaces (versus seed surfaces

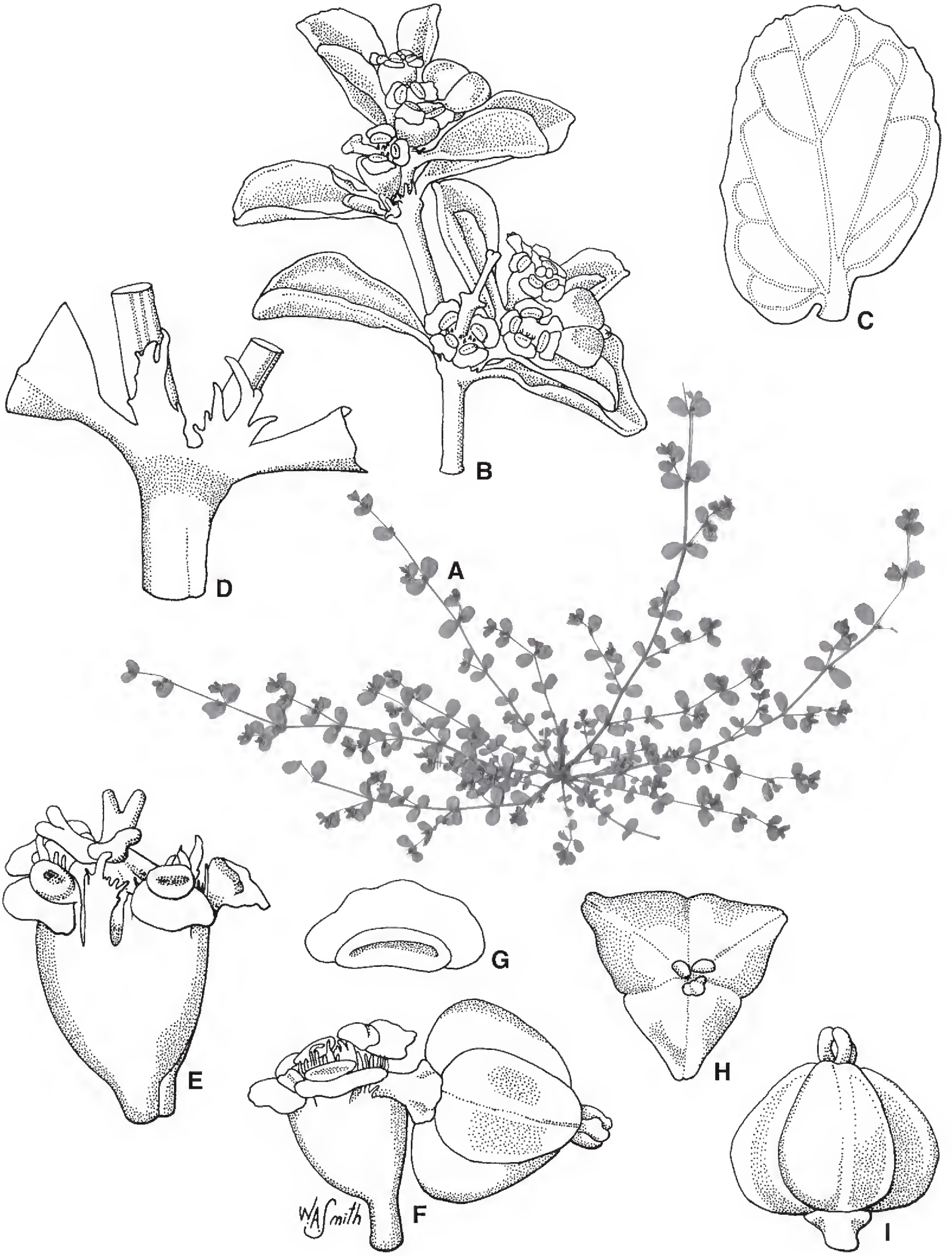

Fig. 17. ***Euphorbia philochalix.*** A. habit ×0.6. B. branchlet with cyathia ×6. C. leaf ×8. D. stipules ×16. E. cyathia with female flower ×24. F. cyathia with fruit ×16. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A from *Thomson 3515* (DNA); B–C, & F–I from *Alford 1285* (PERTH); E from *Hassall 73100* (BRI). Del. W.Smith

with 3–6 distinct transverse ridges for *E. drummondii*), capsules broad to very broad ovate in outline which are generally smaller in dimensions (1.3–1.5(1.8) × 1.5–1.8(2.1) mm versus broadly elliptic in outline, 1.6–1.8 × 1.7–1.9 mm for *E. drummondii*), seeds broad-obovate in outline (versus oblong-obovate for *E. drummondii*) and styles that are bifid for 1/3–1/2 of their length (versus style entire or scarcely bifid for *E. drummondii*).

***Etymology*:** The specific epithet is a noun in apposition and is from Greek *philo*-, loving, fond of, and *chalix,* calcium, in reference to the usual habitat of this species, namely on soils associated with limestone.

43. Euphorbia porcata Halford & W.K.Harris, **species nova** quondam putabatur eadem *E. drummondii* Boiss. esse sed superficie dorsalis seminis porca irregulari longitudinali in medio praedita superficie ventrali seminis ± laevis (ad vicem superficiebus seminis porcis 3–6 distinctis transversis), glandulis involucralibus 0.1–0.15 × 0.1–0.2 mm sine ore incrassata (ad vicem glandulis 0.15–2 × 0.2–0.4 mm) differt. Saepe dicitur *E. porcata* cum *E. ferdinandi* Baill. var. *ferdinandi* crescat sed stylis 1/3–1/2 longitudinis bifidis (ad vicem stylis integris vel vix bifidis), glandulis involucralibus sine ore incrassato seminis superficie dorsali porca longitudinali irregulari ad medio praedita (ad vicem superficie laevi), capsulis longitudine latitudinem aequa perlato-ovatis vel lato-ellipticis a latere visus 1.4–2 × 1 4–2 mm (ad vicem capsulis 1.4–1.9 × 1.3–1.7 mm) distinguenda. **Typus:** Queensland. Gregory North District: Ethabuka Station, *c.* 3 km S of homestead, 112 km NW of Bedourie, 26 June 2010, *D.Halford QM84 & P.I.Forster* (holo: BRI, iso: AD, DNA, NSW, PERTH, *distribuendi*).

Monoecious, annual or herbaceous perennial with thickened woody taproot, to 30 cm high, many stems arising from rootstock, the whole plant glabrous. **Stems** mostly prostrate or ascending, sometimes erect, much branched, smooth. **Interpetiolar stipules** narrow-triangular, 0.5–1.1 mm long, bipartite, glabrous; margin serrulate or laciniate. **Leaves**: petiole *c.* 0.2 mm long, smooth; blade oblong or oblanceolate, 4–8 mm long, 2–5 mm wide, 1.6–2.4 times longer than wide; adaxial surface pale green or reddish green, smooth (rarely minutely papillose); abaxial surface similar to but paler than adaxial surface; base asymmetric with one side cordate or truncate, the other cuneate or obtuse; margin serrulate or sparingly minutely toothed; apex retuse or rounded. **Cyathia** solitary at the nodes, sometimes gathered together on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles *c.* 0.2 mm long, smooth. **Involucres** turbinate, 0.5–0.8 mm long, 0.6–0.8 mm across; lobes 5, triangular, 0.2–0.3 mm long, margin entire; glands 4, stipitate, cupuliform, with distinct central pit, transverse-oblong to orbicular in outline, 0.1–0.15 mm long, 0.1–0.2 mm wide, red; gland appendages inconspicuous or absent, spreading radially, transverse-linear, 0.05–0.15 mm long, *c.* 0.2 mm wide, pink, glabrous, margin entire; bracteoles 0.5–0.7 mm long, adnate for 1/3–1/2 of their length to involucre, free portion entire or divided into few to numerous subulate glabrous segments. **Staminate flowers** 3–10 per cyathium; pedicels 0.6–1.1 mm long; staminal filaments 0.15 mm long. **Pistillate flowers**: styles 0.2–0.4 mm long, spreading, recurved distally, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices slender and terete or stout and clavate. **Capsules** exserted from involucre on pedicel to 1.3 mm long, very broad-ovate or broad-elliptic in lateral view, 1.4–2 mm long; 1.4–2 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate in outline, 1–1.3 mm long, 0.5–0.7 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal faces convex or concave, with ± medial longitudinal irregular ridge; ventral faces concave, usually smooth or faintly irregularly ridged; exotesta thin, of even thickness over surface, white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta pale brown to red-brown. *n* = 11. **Figs 18, 27M.**

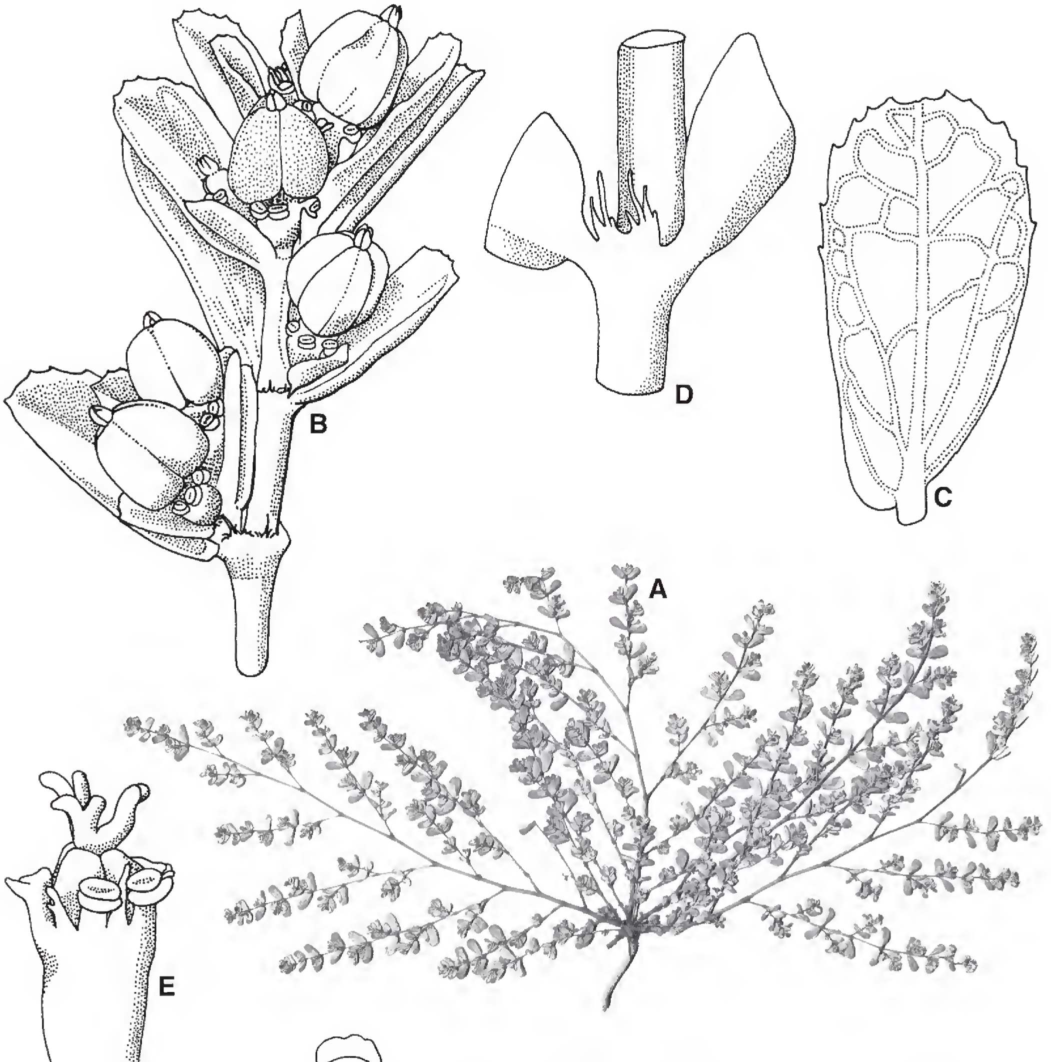

Fig. 18. ***Euphorbia porcata***. A. habit ×0.4. B. branchlet with cyathia ×8. C. leaf x8. D. stipules ×12. E. cyathia with female flower ×24. F. cyathia with fruit ×16. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A from *Halford QM9 & Forster* (BRI); B–I from *Halford QM30 & Forster* (BRI). Del.W. Smith.

***Additional selected specimens examined*:** **Western Australia.** 18 km N of Overlander Roadhouse on North West Coastal Highway, *c.* 33 km S of Gladstone, Sep 1985, *Wilson 12201* (BRI, PERTH); 42 km from Agnew along road to Wiluna, Sep 1982, *Strid 20156* (PERTH); Damboring, *c.* 46 km N of Wongan Hills, Mar 1968, *Wilson 6488* (PERTH); Rundall River N.P., Little Sandy Desert, Apr 1979, *Mitchell 873* (DNA). **Northern Territory.** 46 km N [of] Three-Ways; Stuart Highway, Feb 1988, *Thomson 2241* (DNA); Stirling Bore, 20 miles [*c.* 32 km] S of Barrow Creek township, Sep 1955, *Perry 5345* (BRI, DNA, MEL, NSW); George Gill Range, Stokes Creek, Oct 1986, *Thomson 1534* (DNA); Maryvale Station, junction of Blackhill Bore and Maryvale Road, Aug 1988 *Barritt 745* (DNA); Armata Road, 27 km S [of] t/off from old road to Uluru, Apr 1988, *Thomson 2298* (DNA). **Queensland.** Gregory North District: Cravens Peak, 194 km by road SW of Boulia, Painted Gorge, 12 km by road S of 12 Mile Bore, Apr 2007, *Thomas 3505 & Turpin* (BRI); Cravens Peak, 13.6 km S along shotline track from Ocean Bore – Painted Gorge Track, 135 km SW of Boulia, Jun 2010, *Halford QM9 & Forster* (BRI); *c.* 33 km N of Bedourie on road (Diamantina Development Road) to Boulia, Jun 2010, *Halford QM30 & Forster* (BRI). Warrego District: 75 km NW of Charleville on road to Adavale, Sep 2005, *Halford Q8594 & Thomas* (BRI). Gregory South District: 25 miles [*c.* 40 km] E of Birdsville, May 1975, *Hassall 7521* (BRI); 3 miles [*c.* 4.8 km] N of Santos, May 1973, *Hassall 7343* (BRI). **South Australia.** Dulkaninna Station, Apr 1997, *Smyth 48* (AD, MEL); Dulangari, May 1986, *Conrick 2057* (AD); Arabana Hill, 2 km N of Lake Arthur, Mar 1987, *Badman 1960* (AD); 0.5 miles [*c.* 800 m] SW of Hawker Gate, on Quinyambie Station, Jun 1955, *Johnson 970 & Constable* (NSW). **New South Wales.** Cameron Corner, Sturt N.P., Sep 1989, *Wiecek 250 et al.* (BRI, NSW); 1.5 km NE of Joulnie homestead, May 1973, *Hassall 7318* (BRI); W bank of the salt lake, 45 km SSE of Milparinka, Sep 1971, *DeNardi 822* (AD, NSW); S shore of Menindee Lake, Kinchega N.P., Jun 1984, *Dalby 84/06* (NSW).

***Distribution and habitat*:** *Euphorbia porcata* is widespread across the arid zone in Australia where it extends from WA, through SA and the southern part of the NT to south-western Qld and western NSW (**Map 43**).

It is recorded growing on sand dunes, floodouts or in drainage lines or dune swales, in hummock grassland, *Acacia* spp. shrubland/woodland or *Eucalyptus* spp. woodland communities, on mostly sandy to sandy loam soils.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from April to October.

***Notes*:** *Euphorbia porcata* has previously been identified as *E. drummondii*, but differs from that species in its dorsal seed surface having a medial longitudinal irregular ridge and the ventral seed surface ± smooth (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*), and smaller involucral glands that lack a thickened rim (0.1–0.15 × 0.1–0.2 mm versus 0.15–0.2 × 0.2–0.4 mm for *E. drummondii*).

Euphorbia porcata has often been recorded growing with *E. ferdinandi* var. *ferdinandi*. It is distinguished from that species by its divided styles (styles bifid for 1/3–1/2 of their length versus entire or scarcely bifid for *E. ferdinandi* var. *ferdinandi*), involucral glands lacking a thickened rim, dorsal seed surface having a medial longitudinal irregular ridge (versus seed surface smooth for *E. ferdinandi* var. *ferdinandi*) and capsules as wide as long (very broad-ovate or broad-elliptic in lateral view, 1.4–2 mm × 1.4–2 mm versus elliptic in lateral view, 1.4–1.9 × 1.3–1.7 mm for *E. ferdinandi* var. *ferdinandi*).

The seeds are more or less uniform over the eastern part of the species range. The collections seen of this species from WA have slightly shorter seeds with a more well defined medial longitudinal ridge. Further collections and field studies are warranted to establish the significance of this variation.

***Etymology*:** The specific epithet is from Latin *porcatus*, ridged, in reference to the irregular longitudinal medial ridge along the dorsal faces of the seeds of this species.

44. *Euphorbia prostrata Aiton, *Hort. Kew.* 2: 139 (1789); *Chamaesyce prostrata* (Aiton) Small, *Fl. S.E. U.S. [Small]* 713, 1333 (1903). **Type:** cultivated at Kew, origin in the West Indies, in 1758, *P. Miller s.n.* (holo: BM 510671, *n.v.*).

***Illustrations*:** Auld & Medd (1987: 161); Carter (1988: 422, fig. 78, 2); James & Harden (1990: 428) as *Chamaesyce prostrata*; Lin *et al.* (1991: 244, fig. 18), as *Chamaesyce prostrata*.

Monoecious, annual to 5 cm high, many stems arising from slender taproot. **Stems** prostrate to weakly ascending, much branched, smooth, with moderately dense to dense indumentum in a longitudinal band; hairs spreading, straight to recurved, to 0.3 mm long. **Interpetiolar stipules** narrow-triangular to triangular, 0.3–1 mm long, bipartite or entire, glabrous or occasionally with scattered hairs; margin laciniate or obscurely toothed. **Leaves**: petiole 0.4–1 mm long, smooth, glabrous or nearly so; blade oblong, elliptic or rotund, 2.2–8.5 mm long, 1.2–4.5 mm wide, 1.5–2 times longer than wide; adaxial surface green to blue-green occasionally with reddish tinge along margin, smooth, glabrous; abaxial surface grey-green occasionally with reddish tinge along the midline, smooth, glabrous or with sparse to moderately dense indumentum consisting of spreading hairs 0.1–0.3 mm long; base asymmetric with one side shallowly cordate, the other rounded; margin sparingly minutely toothed; apex acute to rounded. **Cyathia** solitary at the nodes, often gathered together on short leafy lateral branchlets with subtending leaves usually slightly smaller than primary stem leaves; peduncles 0.5–2.5 mm long, smooth, glabrous. **Involucres** turbinate, 0.5–0.7 mm long, 0.4–0.6 mm across; lobes 5, triangular, 0.1–0.2 mm long, margin fimbriate; glands 4, stipitate, patelliform or cupuliform, with a tangential trough or distinct central pit with a somewhat thickened rim, transverse-oblong to orbicular in outline, 0.05–0.1 mm long, 0.1–0.3 mm wide, red or reddish-purple; gland appendages conspicuous, spreading radially, transverse-oblong, 0.05–0.1 mm long, 0.1–0.2 mm wide, pink, red or white, glabrous, margin entire or undulate; bracteoles filamentous, 0.4–0.5 mm long, glabrous. **Staminate flowers** 3–5 per cyathium; pedicels 0.5–0.7 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.2–0.3 mm long, erect to spreading, recurved distally, smooth, glabrous, each bifid for *c.* 1/2 of their length, the apices clavate. **Capsules** exserted from involucre on pedicel to 2 mm long, broad to very broad-ovate in lateral view, 1–1.5 mm long, 1.1–1.5 mm across, shallowly 3-lobate with keels acute, smooth, with a sparse to moderately dense indumentum mostly confined to the keels; hairs spreading, 0.1–0.2(0.5) mm long; hypogynous disc entire. **Seeds** ovate in outline, 0.8–1 mm long, 0.5–0.6 mm tangentially, 0.4–0.6 mm radially, tetraquetrous in cross section; dorsal and ventral faces ± planar, with 4–7 distinct transverse acute ridges; exotesta thin, of even thickness over surface, pale brown or grey-white, microreticulate or microgranulate especially on ridge crests, becoming mucilaginous (very thin layer) when moistened; endotesta pale brown. **Fig. 27N.**

Additional selected specimens examined: **Western Australia.** near work shed, Karijini Ranger Station, Karijini N.P., Sep 2006, *Halford Q9213* (BRI, PERTH); Naval Base, Fremantle to Rockingham, Jan 1984, *Keighery 6533* (PERTH); roadside (W) on causeway N end, W of T27 electricity pole, Garden Island, Jul 2003, *Dodd 847* (PERTH); 2.5 km W of Mundijong, junction Mundijong and Kargotich Roads, Mar 1999, *Davis 8796* (BRI, PERTH); corner of Kargotich & Mundijong Roads, Mundijong, May 2009, *Hislop 3878* (BRI, MICH). **Northern Territory.** Camfield Station homestead, Jul 1983, *Kernot s.n.* (DNA [D0024788]); Brunette Downs Station, Apr 1988, *Kimbel 34* (DNA); Tangentyere Nursery, Alice Springs, Nov 1995, *Albrecht 7079* (DNA). **Queensland.** COOK DISTRICT: Boigu Island, *c.* 8 km S of PNG mainland, Oct 1992, *Waterhouse BMW1444* (BRI). BURKE DISTRICT: Palm Grove, Lawn Hill N.P., May 1990, *Latz 11635* (DNA). LEICHHARDT DISTRICT: Charles Street, Springsure, Aug 2004, *Halford Q8320* (BRI); Leichhardt Hotel, Taroom, Mar 2004, *Halford Q8189 & Edginton* (BRI). PORT CURTIS DISTRICT: Raglan Creek crossing, 21 km W of Mt Larcom, Nov 2003, *Halford Q8066 & Forster* (BRI). BURNETT DISTRICT: Lions Park, Kingaroy Street, Kingaroy, Mar 2004, *Halford Q8171 & Edginton* (BRI). MORETON DISTRICT: Peregian Beach, Avocet Parade, Jan 2000, *Harris 112* (BRI); Guanaba, Coomera River, 5 km SW of Oxenford, property of I. Cairns, Apr 2003, *Forster PIF29296* (BRI). **New South Wales.** Kyogle District, Dec 1957, *Vane s.n.* (NSW 541519); Lismore, Mar 1957, *Flynn s.n.* (NSW 612664); Narrabri Golf Club, 1996, *s.coll.* (NSW 398987); Bective Travelling Stock Route, alongside Peel River, Jan 1995, *Hosking 1074 & Sullivan* (NSW, MEL); Tamworth Regional Botanic Gardens, Oxley Park, Tamworth, Mar 1999, *Hosking 1692 & Bayliss* (MEL, NSW); Strathfield, Mar 1954, *Ford s.n.* (NSW 612601).

Distribution and habitat: *Euphorbia prostrata* is a native to tropical and subtropical America now naturalised throughout much of the warmer regions of the world, including Australia. In Australia it is common in urban centres in coastal and subcoastal parts of Qld and NSW, with scattered occurrences through north-western Qld, NT and in the Pilbara and Perth regions, WA (**Map 44**). It grows in sunny situations on disturbed open ground, road sides, river banks, lawns, garden beds and in cracks of footpaths.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from January to March.

***Notes*:** In Australia, *Euphorbia prostrata* has been confused with *E. maculata* and *E. australis*. *E. prostrata* is easily distinguished by having capsules sparsely to moderately densely hairy along the keels and more or less glabrous between the keels, and seed surface with 4–7 distinct transverse acute ridges.

There are two forms of this naturalised species in Australia. The most common and widespread form has a slender habit with hairs *c.* 0.2 mm long on the stems and the leaves are ± glabrous except for a few scattered hairs on the abaxial surface and along the margins. The second form has a more robust habit with hairs up to 0.3 mm long on the stems and the leaves have a sparse to moderately dense indumentum consisting of spreading, hairs 0.1–0.3 mm long. The longer indumentum gives the plants a shaggy appearance. This second form is recorded in the Perth region, WA (e.g. *Davis 8796*, *Keighery 6533*, *Hislop 3878*) and at a single locality near Wandoan, Qld (90 km NW of Wandoan, Jan 2005, *Ward s.n.* [BRI (AQ723922)]).

45. Euphorbia psammogeton P.S.Green, *Kew Bull.* 48: 314 (1993); *Chamaesyce psammogeton* (P.S.Green) P.I.Forst. & R.J.F.Hend., *Novon* 5: 323 (1995). **Type:** [New South Wales.] Lord Howe Island, Blinky Beach, 13 November 1963, *P.S.Green 1625* (holo: K 186489).

Euphorbia atoto var. *imbricata* Boiss., in A.DC., *Prodr.* 15(2): 13 (1862). **Type:** [Queensland. PORT CURTIS DISTRICT:] Port Curtis, November 1847, [*J.*]*Macgillivray B65* (holo: K).

***Illustrations*:** Stanley & Ross (1983: 414, fig. 65B), as *E. sparrmannii*; James & Harden (1990: 429), as *Chamaesyce sparrmannii*; Green (1993: 315, fig. 2, A1–5; 1994: 236, fig. 47, A–D).

Monoecious, herbaceous perennial, to 35 cm high, few to many stems arising from woody taproot. **Stems** prostrate or ascending to erect, sparingly to much branched, smooth, glabrous. **Interpetiolar stipules** triangular to broad-triangular, 1–2 mm long, entire or bifid to bipartite, glabrous abaxially, hairy adaxially with conspicuous ascending white hairs to 0.15 mm long; margin irregularly serrulate. **Leaves**: petiole 2–3 mm long, smooth; blade obovate, elliptic or oblong-elliptic, 12–28 mm long, 5–17 mm wide, 1.3–2.4 times longer than wide; adaxial surface green, blue-green or grey-green, smooth, glabrous; abaxial surface similar to but paler than adaxial surface; base asymmetric with one side cordate, the other rounded; margin sparingly minutely toothed or entire; apex obtuse to rounded. **Cyathia** in congested 4–6 branched dichasial cymes together with a solitary cyathium at the distal nodes; peduncles 4–15 mm long; bracts leaf-like but smaller than the primary stem leaves; cyathial peduncles 1–3(6) mm long. **Involucres** turbinate, 1.5–2 mm long, 1.5–2 mm across; lobes 5, triangular, 0.4–0.8 mm long, margin entire or laciniate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, 0.4–0.5 mm long, 0.7–1 mm wide, pale green; gland appendages conspicuous, spreading radially, transverse-linear or lunate, 0.2–0.4 mm long, 0.6–1.3 mm wide, white, glabrous, margin entire; bracteoles 0.9–1.2 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into numerous ± linear hirsute segments. **Staminate flowers** (2)5–10(20) per cyathium; pedicels 0.9–1.6 mm long; staminal filaments 0.3–0.5 mm long. **Pistillate flowers**: styles 0.7–0.8 mm long, spreading, recurved distally, smooth and glabrous, each bifid for *c.* 1/2 of their length, the apices terete. **Capsules** exserted from involucre to 3.5 mm long, very broad-ovate in lateral view, 2.8–3 mm long, 3.5–3.9 mm across, shallowly or deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** orbicular or very broad-ovate in outline, 1.5–1.8 mm long, 1.4–1.5 mm tangentially, 1.4–1.6 mm radially, ± suborbicular or somewhat trigonal in cross section; ventral and dorsal faces convex, with irregular narrow rounded ridges; exotesta thin, of even thickness over surface, white, microreticulate, not becoming mucilaginous when moistened; endotesta red-brown. $n = 8$. **Fig. 27O.**

Additional selected specimens examined**: Queensland.** South Kennedy District: Eimeo Beach, *c.* 10 km N of Mackay, Aug 1976, *Henderson H2400* (BRI). Port Curtis District: Freshwater Creek, Shoalwater Bay Training Area, Nov 2001, *Denley Samp55* (BRI); beach between Emu Point and Rocky Point at Emu Park, Jul 1977, *Batianoff & McDonald 109* (BRI); Deepwater N.P., 40 km E of Miriam Vale, Oct 1989, *Gibson TO1868* (BRI). Wide Bay District: Coonarr Beach, SE of Bundaberg, Nov 1996, *Bean 11243* (BRI); Woodgate, Sep 2004, *Halford Q8340a* (BRI, MEL, NSW). Moreton District: Bishop Island, E of Brisbane, Apr 1932, *Blake 3336 & Everist* (BRI); Hercules Bank, S of Brisbane River, Jul 1930, *Hubbard 3487* (BRI); unnamed island between Tiger Mullet Channel and Whalleys Gutter, *c.* 6.5 km ENE of Jacobs Well, Sep 2003, *Halford Q7915 & Batianoff* (BRI). **New South Wales**. Fingal Point [Head], *c.* 2.5 miles [*c.* 4 km] SE of Tweed Heads, Jun 1962, *Constable 3050* (NSW); Angourie – Headland S of blue pools small path, Yurigu N.P., Sep 1993, *Clemesha s.n.* (NSW 279169); S of Woolgoolga – Headland, Jan 1971, *Whaite & Whaite 3471* (NSW); Lord Howe Island, North Beach, Mar 1971, *Rodd 1759* (NSW); Lord Howe Island, Blinky Beach, Mar 2001, *Le Cussan 1123* (BRI); Big Gibber, Myall Lakes, E of Bombah Point, Feb 1969, *Blaxell 207* (NSW); Wamberal Beach, *c.* 10 km E of Gosford, Aug 1985, *Bishop 803 et al.* (NSW); Narrabeen, Nov 1912, *Hamilton s.n.* (NSW 612475); Currarong – Beecroft Head, Apr 1936, *Rodway 2182* (NSW); Currarong, Dec 1987, *Clarke s.n.* (NSW 612457).

Distribution and habitat**:** *Euphorbia psammogeton* occurs along the east coast from Mackay, Qld, south to Currarong, on the south coast of NSW and Lord Howe Island (**Map 45**). It grows on beach sands often on exposed frontal dunes just above the high tide mark.

Phenology**:** Flowers and fruits have been collected throughout the year.

Notes**:** *Euphorbia psammogeton* is similar to *E. obliqua* and *E. pallens*. It differs from both species by having the seed surface with faint irregular narrow rounded ridges (versus seed surface smooth for *E. obliqua* and *E. pallens*), and larger gland appendages (0.2–0.4 mm long versus up to 0.1 mm long for *E. obliqua* and *E. pallens*). It also differs from *E. obliqua* by having its cyathia in dichasial cymes (versus cyathia solitary at the nodes for *E. obliqua*).

46. Euphorbia psilosperma Halford & W.K.Harris, **species nova** ut videtur maxime arcte cum *E. biconvexa* Domin, *E. coghlanii* F.M.Bailey, *E. trigonosperma* Halford & W.K.Harris cognata sed ab eis capsulis majoribus, seminibus comparate latioribus et stylis ± integris. Hae differentiae in tabula 2 breviter repetant. **Typus:** Western Australia. 227 km SW [of] Broome on Great Northern Highway, 11 May 1991, *B.G.Thomson 3630* (holo: NT; iso: DNA).

Monoecious, herbaceous perennial to 20 cm high, many stems arising from woody taproot. **Stems** ascending to erect, much branched, smooth, glabrous (rarely with a few scattered white, spreading hairs *c.* 0.1 mm long). **Interpetiolar stipules** narrow-triangular, 0.5–0.6 mm long, bipartite, glabrous; margin entire. **Leaves**: petiole 1–2 mm long, smooth, glabrous; blade narrow-oblong or narrow-ovate, 7–20 mm long, 1–5 mm wide, 3.6–10 times longer than wide; adaxial surface green, smooth, mostly glabrous; abaxial surface pale green, smooth, glabrous; base asymmetric with one side cordate, the other obtuse; margin entire; apex acute to obtuse. **Cyathia** solitary at the nodes, occasionally clustered on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles *c.* 1 mm long, smooth, glabrous. **Involucres** turbinate, 0.7–0.8 mm long, 0.8–0.9 mm across; lobes 5, triangular, *c.* 0.5 mm long, margin entire or ciliate; glands 4, stipitate, cupuliform, with shallow central pit or longitudinal trough, transverse-elliptic in outline, 0.2–0.3 mm long, 0.4–0.5 mm wide, pale green or pink; gland appendages conspicuous, spreading radially, transverse-elliptic, 0.1–0.4 mm long, 0.4–1.2 mm wide, white, glabrous, margin entire; bracteoles 0.5–0.8 mm long, adnate for *c.* 1/2 of their length to involucre, free portion divided into few subulate glabrous segments. **Staminate flowers** 5–10 per cyathium; pedicels 0.7–1.2 mm long; staminal filaments 0.2–0.3 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, spreading, smooth, glabrous, each entire or scarcely bifid distally, the apices terete. **Capsules** exserted from involucre on pedicel to 2.5 mm long, transversely broad-elliptic in lateral view, 2–2.2 mm long, 2.8–3 mm across, deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** very broad-ovate in outline, 1.2–1.4 mm long, 0.9–1.2 mm tangentially, 0.9–1.3 mm radially, tetragonous, trigonal or suborbicular in cross section; dorsal and ventral faces planar or convex, smooth; exotesta thin, of even thickness over surface, grey-white, ± smooth, becoming mucilaginous when moistened; endotesta red-brown. **Figs 19, 27P.**

***Additional selected specimens examined*:** **Western Australia.** Derby to Broome road, 20.3 km S (by road) of Derby, Apr 1985, *Aplin 77 et al.* (PERTH); 63 miles [*c.* 101 km] E of Derby on road to Fitzroy Crossing, Mar 1967, *Power 190* (PERTH); just NW of Wolf Creek Crater, Apr 1979, *George 15290* (PERTH); between Port Hedland and Mundabullangana Station, Feb 1962, *George 3339* (PERTH). **Northern Territory.** 2 km S of Daly Waters on Stuart Highway, Feb 1988, *Thomson 2237* (DNA); 28 km S [of] Lajamanu – Tanami, Feb 1988, *Wilson 1003* (DNA); Barkly Tableland, Attack Creek, Stuart Highway, Jul 1974, *Carr 2567 & Beauglehole ACB46346* (MEL, NSW).

***Distribution and habitat*:** *Euphorbia psilosperma* occurs in scattered localities from near Port Hedland, WA, eastward to Daly Waters, NT (**Map 46**). It grows on red sands on aeolian dunes or plains in *Acacia* open shrubland or mixed low woodland communities. It has been noted on specimen labels, *George 3339 & 15290* (PERTH), to be growing in areas "recently burnt".

***Phenology*:** Flowers and fruits have been collected in February and April.

***Notes*:** *Euphorbia psilosperma* seems most closely related to *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*. It differs from these species by having larger capsules, relatively broader seeds and more or less entire styles. These differences are summarized in **Table 2**.

***Etymology*:** The specific epithet is from Greek *psilo-*, bare, bald, smooth, and *-spermus*, seeded, in reference to the smooth seeds of this species.

47. Euphorbia schizolepis F.Muell. ex Boiss., in A.DC., *Prodr.* 15(2): 20 (1862); *Euphorbia schizolepis* F.Muell. ex Boiss. var. *schizolepis*, Benth., *Fl. Austral.* 6: 47 (1873). **Type:** [Northern Territory.] Hooker's Creek, *s.d.*, *F.Mueller s.n.* (lecto [here designated]: K 186490; isolecto: MEL 61123).

***Illustrations*:** Wheeler (1992: figs 184L, 185L, 186L); Dunlop *et al.* (1995: 218, fig. 72).

Monoecious, herbaceous perennial to 30 cm high, few to many annual stems arising from crown of thick woody taproot. **Stems** decumbent or erect, sparingly to much branched, smooth, with a moderately dense to dense indumentum; hairs white, weakly appressed to ascending or spreading, crispate, to (0.4)2 mm long. **Interpetiolar stipules** subulate, 1–2.1 mm long, entire or bipartite, hairy as for stems; margin entire or laciniate or parted into few filiform segments. **Leaves**: petiole 1–3 mm long, smooth, with indumentum as for stems; blade ovate to broad-ovate, sometimes somewhat falcate, 11–22 mm long, 7–18 mm wide, 1.2–3 times longer than wide; adaxial surface green or glaucous, papillose, with a sparse to moderately dense indumentum; hairs spreading to ascending, crispate, to 0.8 mm long; abaxial surface similar to but paler than adaxial surface; base asymmetric with one side cordate, the other rounded; margin serrulate sometimes only distally; apex obtuse or acute. **Cyathia** solitary at the nodes; peduncles 2–5.5 mm long, smooth, indumentum as for stems. **Involucres** turbinate, 1.7–2.5 mm long, 2.5–3 mm across; lobes 5, triangular, 0.5–1 mm long, margin entire; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong or transverse-elliptic in outline, 0.5–1.1 mm long, 1–2.2 mm wide, pale green; gland appendages conspicuous, spreading radially, obdeltoid or oblong, 0.6–2 mm long, 2–3 mm wide, pink or white, glabrous or moderately densely hairy on abaxial surface and on adaxial surface distally, margin toothed or deeply laciniate; bracteoles 1.6–3 mm long, adnate for 1/3–1/2 of their length to involucre, free portion divided into few ± linear villose or plumose segments. **Staminate flowers** 30–40 per cyathium; pedicels 2.2–3.8 mm long; staminal filaments 0.7–1(1.5) mm long. **Pistillate flowers**: styles 1.2–2.7 mm long, connate at the base into a column for *c.* 1/4 of their length, erect to spreading, recurved distally, smooth or papillose abaxially, glabrous or pubescent abaxially, each bifid for 1/3–1/4 of their length or entire, the apices terete. **Capsules** exserted from involucre on pedicel to 7 mm long, transversely broad-

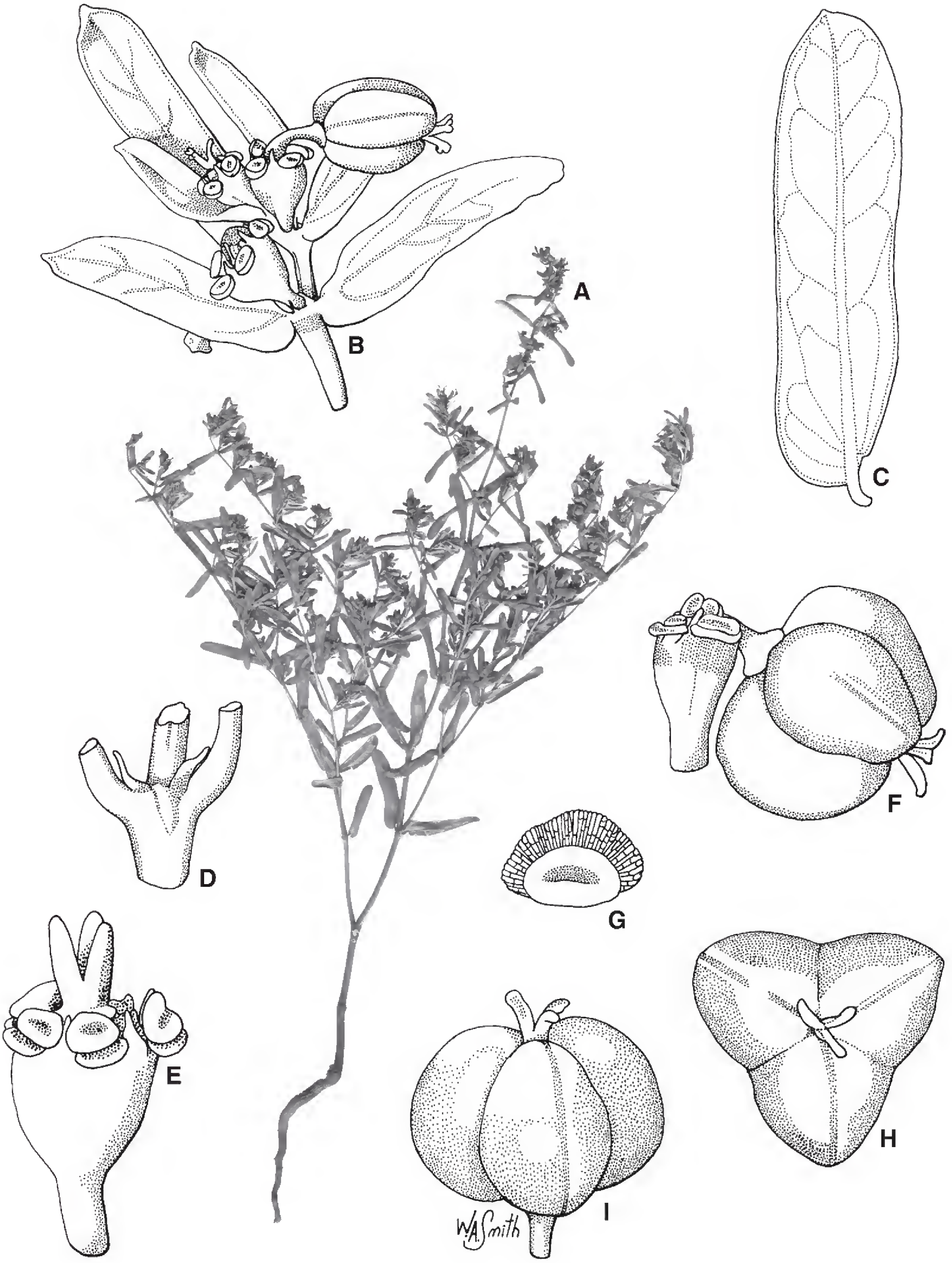

Fig. 19. ***Euphorbia psilosperma***. A. habit ×0.8. B. branchlet with cyathia ×8. C. leaf ×4. D. stipule ×16. E. cyathium with female flower ×24. F. capsule with cyathium ×12. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×12. I. capsule, lateral view ×12. A from *Thomson 3630* (NT); B from *Power 190* (PERTH); C, D, F–I from Thomson 2237 (DNA); E from *Wilson 1003* (DNA). Del. W.Smith.

elliptic in lateral view, 3.2–5 mm long; 3.6–5 mm across, shallowly to deeply 3-lobate with keels obtuse, papillose, with a dense indumentum; hairs spreading or appressed-ascending, to 2 mm long; hypogynous disc entire. **Seeds** oblong-ovate in outline, 2.5–3.2 mm long, 1.8–2.3 mm tangentially, 1.6–1.9 mm radially, ± tetragonous in cross section; dorsal faces convex; ventral faces ± planar; all faces with 4–6 prominent broad, flat-topped, transverse ridges; exotesta of uneven thickness over surface, distinctly thicker on ridges, pale brown or grey-white, microreticulate, becoming mucilaginous when moistened; endotesta dark brown. **Fig. 27Q.**

***Additional selected specimens examined*: Western Australia**. old irrigated Research Station, which is 2 km SW of Kimberley Research Station, Kununurra, Mar 1997, *Mitchell 4528* (BRI, PERTH); Smoke Creek, SW of Lake Argyle, May 1980, *Weston 12186* (PERTH); 2 km N of Lennard Gorge, King Leopold Range, Jun 1992, *Halford Q1448* (BRI, PERTH); Napier Range, Tunnel Creek, Apr 1988, *Dunlop 7753 & Simon* (BRI); Kelly Bore, *c.* 25 km E of Ord River homestead, Apr 1977, *Eichler 22385* (PERTH); 6 miles [*c.*10 km] NE of Gordon Downs Station, Jul 1949, *Perry 2441* (AD, BRI, DNA, NSW). **Northern Territory.** Annaburroo Station, *c.* 1 km E of homestead T/O [turnoff], May 2002, *Risler 1788 & Cusack* (DNA); Old Jim Jim Road, Kakadu N.P., Mar 1987, *Clark 872* (DNA); Arnhem Land, Donydji, Jun 1989, *Dunlop 8514 & White* (DNA); 7 miles [*c.* 11 km] W [of] Caledon Bay turnoff, Jun 1972, *Latz 2842* (DNA, NSW); Kakadu Stage 3, road to Gunlom, Apr 1993, *Egan 1937* (DNA); Nitmiluk N.P., NE corner of Park, Apr 2002, *Michell 4056* (DNA); Arnhem Land, near Emu Springs, Sep 1999, *Cowie 8368 & Harwood* (DNA); 3 miles [*c.* 5 km] N of Katherine, Mar 1964, *Lazarides 7057* (AD, BRI, DNA); Mataranka, Elsey N.P., Feb 1994, *Egan 3238 & Cowie* (BRI); Blackfella Creek, Newry Station, Mar 1989, *Russell-Smith 7617* (DNA); Balbarini Creek, 20 miles [*c.* 32 km] E [of] O.T. Downs, Mar 1959, *Chippendale 5524* (AD, BRI, DNA, NSW); Kalkaringi, Mar 1990, *Thomson 3485* (DNA); near Kalkarindji, Mar 1997, *Michell & Calliss 398* (DNA); 10 km S of Mt Stanford, Jun 1974, *Latz 5361* (BRI); Cattle Creek Station, Aug 1994, *Egan 4282* (DNA).

***Distribution and habitat*:** *Euphorbia schizolepis* is confined to northern Australia from Wyndham, WA, east through north-western NT to Gove; with disjunct occurrences in the Napier and King Leopold Ranges, WA and near Cape Crawford, NT (**Map 47**). It grows in a variety of habitats, including tussock grassland, shrubland or eucalypt woodland communities on dark clay soils on plains, or in eucalypt forest/woodland or vine thicket communities on sandy to loam soils on ridges, rocky hills and slopes, or alluvial flats.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from January to July.

***Typification*:** Boissier (1862) cited two collections in his protologue of *Euphorbia schizolepis* namely "Ad Hooker's Creek et in sinu Carpentarie Novae Hollandiae sept. (F. Müller!).....(v.s. in h. Kew)". Two collections, which are considered syntypes of the name *E. schizolepis*, have been located amongst material of *Euphorbia* on loan to BRI from K [**a:** *Euphorbia schizolepis* F.von Mueller, Hookers Creek, DM (K 186490); **b:** *Euphorbia schizolepis* F.von Mueller, Gulf of Carpentaria, DM (K 186491)].

The collection (**a**) from Hookers Creek (K 186490) is here selected as lectotype because it is part of the original material and has morphology that best matches the description in the protologue of this species. There is a collection at MEL [61123] "*Euphorbia schizolepis* F.Mueller, Upper Victoria River" that is a very good match to the material from Hookers Creek (K 186490) and is most likely part of the same collection and is cited here as an isolectotype. The collection (**b**) from the Gulf of Carpentaria (K 186491) is the holotype of Bentham's *E. schizolepis* var. *glabra*. Duplicates of this collection have been located at G-DC (IDC microfiche 800-73. 2416: I. 4) and MEL [61122]. All are referable to *E. carissoides*.

***Notes*:** *Euphorbia schizolepis* is a distinctive species that seems most closely related to *E. kimberleyensis*. For features distinguishing *E. schizolepis* from *E. kimberleyensis*, refer to the 'Notes' section under that species.

The hairs on the stems, leaves and capsules of *E. schizolepis* are typically long (up to 2 mm) and weakly ascending to spreading. The specimens *Forster PIF6007* (Gove Peninsula, 11 km along Dalywoi Bay road [BRI]) and *Wannan 2640 & Anderson* (Woodcutters Mine, S of Darwin [BRI]) are atypical in having short (*c.* 0.2 mm long) appressed hairs.

Table 2. Comparison of some morphological characters between *Euphorbia psilosperma*, *E. biconvexa*, *E. coghlanii* and *E. trigonosperma*.

Character	*E. psilosperma*	*E. biconvexa*	*E. coghlanii*	*E. trigonosperma*
seed shape in outline	very broad-obovate	narrow-obovate or elliptic	oblong to obovate	obovate to very broad-obovate
seed shape in transverse section	tetrogonous, trigonal, suborbicular	biconvex	suborbicular	trigonal
seed size (mm)	1.2–1.4 × 0.9–1.2 × 0.9–1.3	1–1.5 × 0.5–0.9 × 0.9–1.1	1.2–1.4 × 0.8–1 × 0.8–1	1.2–1.6 × 0.6–1 × 0.8–1
capsule size (mm)	2–2.2 × 2.8–3	1.6–2 × 2–2.5	1.8–2 × 1.8–2.4	1.5–2.1 × 1.9–2.6
style division	entire or scarcely bifid at the tip	bifid for 1/2 of their length	bifid for 1/3–2/3 of their length	bifid for 1/2–2/3 of their length

The species as circumscribed here varies in the degree of style division. The typical form has styles divided for 1/3–1/4 of their length (e.g. *Lazarides 7057*, *Mitchell 4528*) and is commonly observed in collections from the Kimberley and Victoria River regions in the southern part of the species range. A second form with entire styles (e.g. *Chippendale 5524*, *Perry 2441*) is more commonly recorded in the northern part of the species range from Darwin to Arnhem Land.

48. Euphorbia schultzii Benth., *Fl. Austral.* 6: 47–48 (1873); *Chamaesyce schultzii* (Benth.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Northern Territory.] Port Darwin, *s.d.*, [*M.Schultz*] *844* (comm. by Schomburgk, 7 December 1871) (lecto [here designated]: K 186494).

Monoecious, annual or herbaceous perennial with thickened woody taproot, 10–40 cm high, with few to many stems arising from base. **Stems** decumbent to erect or prostrate, sparingly to much branched, smooth, with a moderately dense indumentum (rarely glabrous); hairs appressed to spreading, curved or straight, 0.1–1 mm long, white. **Interpetiolar stipules** subulate to narrow-triangular, 0.4–1.2 mm long, deeply bipartite, glabrous or with indumentum as for stems; margin entire or laciniate with teeth often gland-tipped. **Leaves**: petiole 0.4–1 mm long, smooth, with indumentum as for stems; blade narrow-oblong to oblong, narrow-ovate to ovate or oblong-obovate to obovate, (3)4–16 mm long, 1.5–9 mm wide, 1.2–2.9 times longer than wide; adaxial surface green often with reddish tinge, smooth or papillose, glabrous or with a sparse to moderately dense indumentum consisting of ascending to spreading, ± straight hairs 0.2–0.8 mm long; abaxial surface pale green, pink, smooth or papillose; glabrous or sparse to moderately dense indumentum consisting of appressed-ascending to spreading, ± straight hairs 0.1–0.8 mm long; base asymmetric with one side cordate to auriculate, the other rounded to cordate; margin serrate to serrulate, often only along one side and distally (rarely entire); apex obtuse to acute or rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles 0.1–1.5 mm long. **Involucres** turbinate to cupuliform, 0.8–0.9 mm long, 0.7–1.4 mm across; lobes 5, triangular, *c.* 0.4 mm long, margin fimbriate or entire; glands 4, stipitate, cupuliform, with distinct tangential trough and thickened rim, transverse-oblong in outline, 0.1–0.3 mm long, 0.4–0.6 mm wide, pink; gland appendages conspicuous, spreading radially, very broad-obovate or transverse-oblong, 0.1–0.6 mm long, 0.4–0.8 mm wide, white to pink, glabrous, margin entire, erose or shallowly lobed; bracteoles 0.5–0.8 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** 4–20(27) per cyathium; pedicels 0.7–1 mm long; staminal filaments 0.1–0.3 mm long. **Pistillate flowers**: styles 0.2–0.6 mm long, spreading, recurved distally, smooth, glabrous or sparsely hairy, entire or bifid for 1/3–2/3 the length, with terete apices. **Capsules** exserted from involucre on pedicel to 3 mm long, depressed ovate or transversely elliptic to broad-elliptic in lateral view, broadest at or below the equator, 1.5–2.2 mm long, 2–3 mm across, deeply 3-lobate with keels acute, papillose (rarely smooth), glabrous or with a sparse to moderately dense indumentum consisting of appressed to spreading hairs to 0.2 mm long; hairs evenly distributed over surface (rarely confined to keels); hypogynous disc laciniate or entire. **Seeds** ovate or broad-ovate in outline, 1–1.5 mm long, 0.6–0.8 mm tangentially, 0.6–0.8 mm radially, tetraquetrous in cross section; dorsal faces convex to planar; ventral faces planar to concave; all faces with 3–5 prominent ± transverse or irregular, rounded ridges; exotesta thin, of even thickness over surface or of uneven thickness and distinctly thicker on ridges, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta pale to dark brown.

***Distribution and habitat*:** *Euphorbia schultzii* is widespread across northern Australia from the Kimberley, WA through the NT to northern Qld.

***Typification*:** Bentham (1873) in his protologue of *Euphorbia schultzii* cited four collections by M. Schultz from Port Darwin settlement, NT ("N. Australia. Port Darwin, Schultz, n. 15, 237, 844 and 879"). All of these have been located amongst material of *Euphorbia* on loan to BRI from K: *Schultz 15* (K 186495); *Schultz 844* (K 186494); *Schultz 879* (K 186493); *Schultz 237* (K 186492). The collection *Schultz 844* (K 186494) is here chosen as the lectotype of *Euphorbia schultzii* because it has morphology that agrees with the description in the protologue, is the best preserved and most ample of the original material, and has mature capsules and seed attached. The syntypes *Schultz 15* (K 186495); *Schultz 844* (K 186494); *Schultz 879* (K 186493); *Schultz 237* (K 186492) are all referable to *E. schultzii* var. *schultzii* as applied here.

***Notes*:** *Euphorbia schultzii* has been confused with *E. careyi* and *E. australis* in the past. It can be distinguished from both species by the capsules that are distinctly broader than long (1.5–2.2 mm long × 2–3 mm across) and deeply 3-lobate (versus capsules that are more or less as long as wide (1.4–2 × 1.5–2.1 mm for *E. australis*; 1.4–1.6 × 1.6–1.9 mm for *E. careyi*). It also differs from *E. careyi* in having cupuliform involucral glands with a distinct tangential trough and thickened rim rather than patelliform with planar or shallowly concave gland surface.

Two varieties are recognised which can be distinguished using the following key.

Key to varieties of *Euphorbia schultzii*

Capsule hairy . . . . **48a. E. schultzii** var. **schultzii**
Capsule glabrous . . . . **48b. E. schultzii** var. **comans**

48a. Euphorbia schultzii var. schultzii

Euphorbia australis var. *glaucescens* Boiss., in A.DC., *Prodr.* 15(2): 36 (1862). **Type:** [Queensland. Cook District:] sandy banks of the Gilbert River, *s.d.*, *F.Mueller s.n.* (holo: K 186466; iso: MEL 503406, P 698528 element on the right hand side of sheet).

***Illustrations*:** Wheeler (1992: figs 184M, 185M, 186M); Dunlop *et al.* (1995: 218, fig. 72).

Stems erect or prostrate, with a moderately dense indumentum; hairs appressed or spreading, curved or straight, 0.1–1 mm long. **Leaf blades**: narrow-oblong to oblong, ovate or oblong-obovate to obovate, (3)4–16 mm long, 1.5–9 mm wide, 1.7–2.9 times longer than wide; adaxial surface glabrous or with a sparse to moderately dense indumentum consisting of ascending to spreading, ± straight hairs 0.2–0.8 mm long; abaxial surface glabrous or with a sparse indumentum consisting of hairs similar to those on adaxial surface; base asymmetric with one side cordate, the other cuneate to rounded. **Involucres** turbinate to cupuliform, 0.8–0.9 mm long, 0.7–1.4 mm across; gland appendages conspicuous, spreading radially, transverse-oblong, 0.1–0.6 mm long, 0.7–0.8 mm wide, margin entire or irregularly toothed. **Staminate flowers** 10–20 per cyathium. **Pistillate flowers**: styles 0.2–0.6 mm long, glabrous or sparsely hairy, entire or bifid for 1/3–2/3 of their length. **Capsules** depressed ovate or transversely elliptic in lateral view, 1.5–2.2 mm long, 2–3 mm across, with a sparse to moderately dense indumentum consisting of appressed to spreading hairs to 0.2 mm long; hairs evenly distributed over surface (rarely confined to keels); hypogynous disc laciniate or entire. *n* = 11. **Fig. 27R.**

***Additional selected specimens examined*: Western Australia.** along the Ord River at Ivanhoe Crossing, Apr 1977, *Eichler 22177* (PERTH); base of Mt Nyulasy, 198 km N of Halls Creek on road to Kununurra, *c.* 35 km N of Turkey Creek, Apr 1985, *Aplin 1347 et al.* (PERTH); Windjana Gorge N.P., outside drip line immediately in front of Carpenters Gap rockshelter, July 1997, *Wallis LW97A/37* (PERTH); along Millie Windie Road (from Lennard River crossing), Jun 1988, *Wilson 12952* (PERTH); Ord River between Springvale and Bedford, Apr 1972, *Aplin 4851* (PERTH); 39 km S of Forrest River on Duncan Highway, Apr 1977, *George 14452* (PERTH); Geike Range, near Geike Gorge, Apr 1988, *Simon 3986 & Cranfield* (BRI). **Northern Territory.** Meckitt Creek, 2 km S [of] boat ramp, Dec 1986, *Wightman 3301* (DNA); Cape Hotham, Escape Cliff, Mar 1993, *Cowie 3315* (DNA); 11.2 miles [*c.* 18 km] S [of] Batchelor, Mar 1961, *Chippendale 7739* (BRI, DNA, MEL, NSW); Fitzmaurice River, Feb 1994, *Leach 4071* (BRI, MEL); Binjari Settlement, 15 km W of Katherine, Mar 1996, *Barritt 2094* (DNA); Gregory N.P., past Matt Wilson Lookout, Feb 1992, *Cowie 2239 & Brocklehurst* (DNA, MEL). **Queensland.** COOK DISTRICT: Royal Arch Cave section, Chillagoe – Mungana Caves N.P., Jan 2005, *McDonald KRM3542 & Little* (BRI); Newcastle Range between Georgetown and Mt Surprise, Jan 2005, *McDonald KRM3499* (BRI); Mt Eliza, 8 km NW of Mount Surprise, Jan 1993, *Bean 5498 & Forster* (BRI). BURKE DISTRICT: E of the Burke Development Road at the Bang Bang Jumpup, Feb 2006, *Fox IDF3829 & Willson* (BRI). NORTH KENNEDY DISTRICT: 'Maidavale', E of Mingela, Apr 1991, *Bean 2952* (BRI); *c.* 67 km S of Charters Towers near Mt Malakoff, Jun 1998, *Thompson CHA451 & Turpin* (BRI).

***Distribution and habitat*:** *Euphorbia schultzii* var. *schultzii* occurs across northern Australia from the Kimberley region, WA, through the northern area of the NT to near Townsville, north Qld (**Map 48a**). It grows in eucalypt/*Acacia* woodland or eucalypt open forest communities on rocky hills, plateaux or riverine flats, rarely in *Spinifex* grassland on coastal dunes or rocky foreshores. The soils are mostly sandy to loam derived from a range of substrates.

***Phenology*:** Flowers and fruits have been collected throughout the year, particularly from January to June.

***Notes*:** As accepted here, there is some variation in the indumentum form and distribution, and style division of *Euphorbia schultzii* var. *schultzii*. Generally, specimens fall into those with curved, appressed to ascending hairs 0.1–0.3 mm long and those with ± straight, spreading hairs 0.2–1 mm long. Both forms occur throughout the variety's distributional range.

Euphorbia schultzii var. *schultzii* typically has styles divided for 1/3–2/3 of their length. A number of specimens with entire styles (e.g. *Bean 2952*, *McDonald KRM3499*) have been collected from the eastern end (Mt Isa to the Townsville region, Qld) of the varieties range.

The indumentum on the capsules of this variety is typically evenly distributed over the capsule surface. Specimens *Eichler 22177* (from WA) and *Fox IDF3829* (from Qld) are atypical in having the hairs on capsules restricted to their keels.

Collections from the Kimberley, WA generally have narrower ridges on the seed surface and generally shorter (<0.2 mm long) spreading hairs on the stems leaves and capsules (e.g. *Wilson 12952*, *Aplin 4851*, *Aplin 1347 et al.*). Further investigations of these forms are warranted.

48b. Euphorbia schultzii var. **comans** (W.Fitzg.) Halford & W.K.Harris **combinatio et status nova**; *Euphorbia comans* W.Fitzg., *J & Proc. Roy. Soc. Western Australia* 3: 161 (1918). **Type:** Western Australia. Derby, April 1905, *W.V.Fitzgerald 193* (lecto [here designated]: PERTH 2847221; isolecto: NSW 98808).

***Illustration*:** Wheeler (1992: figs 184D, 185D, 186D), as *Euphorbia comans*.

Stems decumbent to erect (rarely prostrate), with a moderately dense indumentum (rarely glabrous); hairs spreading, ± straight, 0.2–0.9 mm long. **Leaf blades**: narrow-oblong to oblong, narrow-ovate to ovate, 6–15 mm long, 2–9 mm wide, 1.2–2.5 times longer than wide; adaxial surface glabrous or with a sparse indumentum consisting of spreading, ± straight hairs 0.5–0.6 mm long; abaxial surface glabrous or with a sparse to moderately dense indumentum consisting of spreading, ± straight hairs 0.5–0.8 mm long; base asymmetric with one side cordate to auriculate, the other rounded to cordate. **Involucres** turbinate, *c.* 0.7 mm long, 0.7–1.4 mm across; gland appendages conspicuous, spreading radially, very broad-obovate or transverse-oblong, 0.1–0.4 mm long, 0.4–0.6 mm wide, margin entire, erose or shallowly lobed. **Staminate flowers** 4–20(27) per cyathium. **Pistillate flowers**: styles 0.2–0.4 mm long, glabrous, bifid for 1/3–2/3 the length. **Capsules** depressed ovate or transversely elliptic to broad-elliptic in lateral view, 1.5–1.8 mm long, 2–2.7 mm across, glabrous; hypogynous disc entire. **Fig. 28A.**

***Additional selected specimens examined*:** **Western Australia.** 11 miles [*c.* 18 km] S of Derby, Jan 1971, *Allan 565* (PERTH); Manguel Creek Station S of the Broome to Derby Road, Apr 1968, *Payne D* (PERTH). **Northern Territory.** Victoria Highway, 57 km W of Katherine, Dec 1994, *Barritt 1693* (DNA, MEL); Nitmiluk N.P., Mar 2001, *Michell 3211* (DNA); Cutta Cutta Reserve, Jan 1993, *Egan 831* (DNA); 43.3 miles [*c.* 70 km] SE [of] Top Springs Store, Apr 1959, *Chippendale 5795* (DNA, MEL); 6 km N of Dunmarra, Jan 1994, *Egan 3025* (DNA); Foelsche River, Jan 1989, *Thomson 2956* (DNA); 30 miles [*c.* 48 km] SSW of Wavehill Station, Jun 1949, *Perry 2220* (BRI, DNA); Birrindudu Range, NW Tanami Desert, May 2004, *Latz 19970 & Brennan* (NT); 50 km W [of] Newcastle Waters homestead, Feb 1989, *Thomson 3188* (DNA); 20 km NE [of] Elliott, Feb 1989, *Thomson 3218* (DNA); 3 miles [*c.*4.8 km] NE [of] Newcastle Waters, Mar 1959, *Chippendale 5431* (BRI, DNA, MEL); 50 km N of Renner Springs on the Stuart Highway, Feb 1988, *Thomson 2238* (DNA); Mittiebah Station, Mitchiebo Waterhole, Mar 1981, *Henshall 3481* (AD, BRI); 46 km N of Three Ways on Stuart Highway, Feb 1988, *Thomson 2242* (DNA). **Queensland.** BURKE DISTRICT: 28.2 km S by road from Musselbrook Mining Camp on road to Camooweal, Apr 1995, *Thomas & Johnson MRS435* (BRI); 1 km N of Dugald River crossing on Julia Creek – Normanton Road, Mar 1977, *Farrell TF782* (BRI); 28.4 km by road from junction of Burke and Gulf Development Roads, towards Flinders River, Jan 2005, *McDonald KRM3447* (BRI).

***Distribution and habitat*:** *Euphorbia schultzii* var. *comans* occurs from Derby, WA, across the north of the NT to Cloncurry, north-western Qld (**Map 48b**). It grows in eucalypt open woodland or *Acacia*/*Grevillea* shrubland communities on sandy soils, on alluvial flats, sand plains, sandstone plateaux or rocky rhyolite, granite or laterite hills. Also found in vine thicket on basalt soils.

***Phenology*:** Flowers and fruits have been collected from December to June (mostly from January to April).

***Typification*:** Fitzgerald (1918) based his description of *Euphorbia comans* on material collected by him from near Derby, Denham and King Rivers, Kimberley, WA. All of these have been located amongst material of *Euphorbia* on loan to BRI from PERTH and NSW: Derby, Apr 1905, *W.V.Fitzgerald 193* (PERTH 2847221, NSW 98808); Denham River, Oct 1906, *W.V.Fitzgerald s.n.* (NSW 612560); King River, Oct 1906, *W.V.Fitzgerald s.n.* (NSW 612552). The collection *Fitzgerald 193* (PERTH 2847221) is here chosen as the lectotype of *E. comans* because it has morphology that agrees with the description in the protologue, and is the best preserved and most ample of the original material. All the syntypes seen are referable to *E. schultzii* var. *comans* as applied here.

***Notes*:** We have reduced *Euphorbia comans* to a synonym of *E. schultzii* and recognised the taxon at the varietal level. It differs from *E. schultzii* var. *schultzii* in having glabrous capsules.

Most of the specimens of this variety seen by us have typically spreading hairs on the stems. A rare form with glabrous stems is represented by *Strong 975*, *976* (Sailor Creek, Rosewood Station, May 1987 [DNA]) and *Russell-Smith 7614 & Lucas* (Blackfellow creek, Newry Station, Mar 1989 [BRI, NT]).

49. *Euphorbia serpens Kunth, in Humb., Bonpl. & Kunth, *Nov. Gen. Sp.* 2: 52 (1817); *Chamaesyce serpens* (Kunth) Small, *Fl. S.E. U.S. [Small]* 709 (1903). **Type:** Venezuela. "Cumana prope Bordones et Punta Araya", *F.W.H.A. von Humboldt & A.Bonpland 407* (holo: P-Bonpl. *n.v.* [IDC microfiche 6209-1. 32: II. 4]).

***Illustration*:** Lin *et al.* (1991: 246, fig. 9), as *Chamaesyce serpens.*

Monoecious, annual or herbaceous perennial with slender taproot, many stems arising from rootstock, the whole plant glabrous. **Stems** prostrate, much branched, smooth, rooting at nodes. **Interpetiolar stipules** broad-triangular, 0.5–0.6 mm long, glabrous; margin lacerate distally. **Leaves**: petiole 0.3–0.6 mm long, smooth; blade broad-oblong, broad-elliptic or rotund, 2.5–4 mm long, 2.5–3.7 mm wide, 1–1.2 times longer than wide; adaxial and abaxial surfaces green, smooth; base ± symmetric, cordate; margin entire; apex retuse. **Cyathia** solitary at the nodes; peduncles 0.5–2 mm long, smooth, glabrous. **Involucres** turbinate, 0.5–0.6 mm long, 0.7–0.8 mm across; lobes 5, triangular, 0.3–0.4 mm long, margin fimbriate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong in outline, *c.* 0.15 mm long, 0.15–0.3 mm wide, purple; gland appendages conspicuous, spreading radially, transverse-oblong or obdeltoid, 0.1–0.2 mm long, 0.3–0.6 mm wide, white, glabrous, margin entire or shallowly lobed; bracteoles 0.8–1 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into few ± linear hirsute segments. **Staminate flowers** 5–8 per cyathium; pedicels *c.* 1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles *c.* 0.4 mm long, spreading, smooth, glabrous, each bifid for *c.* 1/4–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 1.5 mm long, broad-elliptic in lateral view, 1.2–1.4 mm long, 1.4–1.5 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc laciniate. **Seeds** broad-ovate in outline, 0.8–0.9 mm long, 0.6–0.7 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces planar or concave; all faces with 2–4 faint narrow rounded, transverse ridges; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown. **Fig. 28B.**

***Additional selected specimens examined*: South Australia.** Hundred of Wiltunga, section 302, May 1967, *Coley 1316* (AD). **Queensland.** BURKE DISTRICT: Resolution Street, Hughenden, Sep 2009, *Halford Q9699* (BRI). NORTH KENNEDY DISTRICT: Dotterel Close, Douglas, Townsville, Sep 2006, *Hooker NH693* (BRI); Racecourse Road, Ross River South Bank, Townsville, Jan 2005, *Cumming RJC23142* (BRI). MARANOA DISTRICT: McDowall Street, Roma, Feb 2004, *Halford Q8135 & Harris* (BRI). DARLING DOWNS DISTRICT: Jimbour, railway line 1 km NW of township, Jan 2001, *Forster PIF26562 & Harris* (BRI, MEL). MORETON DISTRICT: Tinchi Tamba Wetland Reserve, Brisbane, Dec 2009, *Halford Q99745* (BRI). **New South Wales.** 10 km W of Balranald, Dec 1987, *Thomson 2300* (NSW [mixed collection with *E. dallachyana*], NT).

***Distribution and habitat*:** *Euphorbia serpens* is native of the Americas and is naturalised in Asia, Africa and Australia. In Australia, at present it occurs in scattered localities; in Qld from Townsville, Hughenden, Roma, Jimbour and the Brisbane area, in western NSW near Balranald; and on northern Yorke Peninsula, SA (**Map 49**). It grows in disturbed sites, including roadsides, railway easements, footpaths, urban parklands, garden beds and lawns.

***Phenology*:** Flowers and fruits have been collected in January, February, May, August and December.

***Notes*:** *Euphorbia serpens* is somewhat similar to and easily confused with the native *E. dallachyana.* It differs by having stems rooting at the nodes and generally smaller leaves, capsules and seeds.

The collection, *Copley 1316* (AD) (from a home garden, Yorke Peninsula, SA) is placed here; however, it is atypical when compared with the rest of the material of *E. serpens* in Australia in having somewhat longer stipules that are bipartite.

50. Euphorbia sharkoensis Baill., *Adansonia* 6: 287 (1866). **Type:** [Western Australia.] Sharks Bay, Useless Harbour, in 1863, *Maitl. Brown s.n.* (holo: P 698526 *n.v.* [image seen]; iso: MEL 503410).

Euphorbia drummondii var. *rubescens* Benth., *Fl. Austral.* 6: 49 (1873). **Type:** [Western Australia.] Dirk Hartog's Island, January 1822, *A.Cunningham 223* (holo: K 186499).

Monoecious, annual or herbaceous perennial to 30 cm high, few to many stems arising from slender taproot, the whole plant glabrous. **Stems** prostrate or erect, sparingly to much branched, smooth, sometimes longitudinally ridged. **Interpetiolar stipules** subulate, 0.1–0.9 mm long, bipartite, glabrous; margin entire or laciniate. **Leaves**: petiole 0.5–1.5 mm long, smooth; blade oblong, elliptic or obovate to oblong-obovate, 3.1–14 mm long, 2.2–7 mm wide, 1.4–2.8 times longer than wide; adaxial and abaxial surface blue-green or green sometimes with reddish tinge along margin, smooth, glabrous; base asymmetric with one side cordate, the other cuneate or rounded; margin entire or serrulate to serrate; apex rounded to obtuse. **Cyathia** solitary at the nodes; peduncles 0.3–1 mm long, smooth, glabrous. **Involucres** campanulate or turbinate, 0.5–0.9 mm long, 0.8–1.2 mm across; lobes 5, triangular, 0.2–0.5 mm long, margin fimbriate or laciniate; glands 4, stipitate, patelliform, planar or shallowly concave with tangential trough, transverse-oblong in outline, 0.2–0.3 mm long, 0.4–0.6 mm wide, red; gland appendages conspicuous, spreading radially, transverse-oblong, 0.1–0.3 mm long, 0.4–0.7 mm wide, red or white, glabrous, margin toothed or deeply lobed; bracteoles 0.4–1 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into few subulate glabrous or hirsute segments. **Staminate flowers** 3–8 per cyathium; pedicels 0.4–1.2 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, spreading or ascending, smooth and glabrous, each bifid for 1/3–1/4 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, very broad-ovate or broad-elliptic in lateral view, 1.5–2 mm long, 1.5–2.3 mm across, shallowly 3-lobate with keels acute or obtuse, smooth, glabrous; hypogynous disc entire (rarely laciniate). **Seeds** ovate in outline, (0.9)1–1.5 mm long, 0.7–0.8 mm tangentially, 0.6–0.8 mm radially, tetraquetrous in cross section; dorsal faces planar; ventral faces concave; all faces with faint rounded, irregularly ridges; exotesta thin, of even thickness over surface, or sometimes slightly thicker on ridges, white, microreticulate, becoming mucilaginous when moistened; endotesta red brown. $n = 11$.

***Additional selected specimens examined*: Western Australia.** Airlie Island, July 1987, *Long VL158* (PERTH); Burgundy Bay (Bomb site area), Alpha Island, Montebello Islands, Oct 2000, *Kenneally 11610* (PERTH); Varanus Island, Lowendale Group, May 1991, *Thomson 3496* (DNA, PERTH); Barrow Island, Oct 1980, *Buckley 6956* (PERTH); Barrow Island, Oct 1980, *Buckley 7159* (PERTH); Legendre Island, May 1991, *Thomson 3506* (PERTH); Legendre Island, Dampier Archipelago, Jun 1962, *Royce 7322* (PERTH); 3.5 miles [*c.* 5.6 km] S of Exmouth township, May 1965, *George 6591* (PERTH); Ward Reef track on Thevenard Island, May 1990, *White MRW041* (PERTH); 10.5 km S of Exmouth P.O., on track to beach, 0.5 km E of highway, Jul 1977, *McFarland & McFarland 4* (BRI, PERTH); *c.* 30 km S of Exmouth, along W side of highway, Jul 1977, *McFarland & McFarland s.n.* (PERTH 3995879); near Norcape Lodge, Exmouth, Jul 1977, *McFarland & McFarland s.n.* (BRI [AQ234287]); top of Beagle Hill, Pt [Point] Quobba, *c.* 50 km NNW of Carnarvon, Sep 1987, *Wilson 12623* (PERTH); 25 miles [*c.* 40 km] N of Carnarvon on Quobba Road, Sep 1970, *George 10139* (BRI, PERTH); Dorre Island, Aug 1977, *Weston 10547* (PERTH); S of Eagle Bluff, Peron Peninsula, Shark Bay, *c.* 3.5 km SSE of intersection of Eagle Bluff Road and Denham – Hamelin Road, Oct 1997, *Markey 1625* (PERTH); Taillefer Isthmus, Shark Bay, *c.* 6 km NNW of repeater station site near Goulet Bluff, Oct 1997, *Markey 1797* (PERTH); *c.* 10 km N of Bibby Giddy Outcamp on Heirisson Prong, 30 m SSE of Clough's Bar track at *c.* 2.4 km along track from junction with Useless Loop Road, Sep 1997, *Markey 1733* (PERTH); 10 miles [*c.* 16 km] S of Overlander (near Hamelin Pool), Aug 1973, *Hassall 73103* (BRI); Port Gregory rubbish tip, 2.5 km SE of town, July 1997, *Davis 3612* (PERTH).

***Distribution and habitat*:** *Euphorbia sharkoensis* is confined to the islands and coastal areas of north western WA, from Roeburne to Shark Bay, with a disjunct occurrence near Port Gregory (**Map 50**). It grows in open shrubland or heathland communities on sandy soils on rocky limestone foreshores or coastal sand dunes.

Phenology: Flowers and fruits have been collected from May to October.

Notes: *Euphorbia sharkoensis* seems most closely related to *E. myrtoides*. It can be distinguished from that species by its generally smaller habit, smaller involucral glands, seeds and capsules, longitudinally ribbed stems, faintly irregularly ridged seed surface and fewer staminate flowers per cyathium.

Euphorbia sharkoensis has often been previously identified as *E. drummondii*. It differs from that species by having involucral glands with a planar or shallowly concave gland surface, gland appendages 0.1–0.3 mm long, with a toothed or deeply lobed margin and seeds with a faintly irregularly ridged surface.

Plants from Barrow Island, Montebello Islands and from islands of the Dampier Archipelago (e.g. *Thomson 3496, Buckley 7159, Kenneally 11610*) differ from the typical form by having a more woody habit, stems that are more prominently longitudinally ridged, and leaves that are generally thicker and smaller.

The two collections (4–5 miles [6–8 km] N of Yardie Creek, May 1965, *George 6652* [PERTH]; Onslow, Sep 2006, *Halford Q9293* [BRI]) are tentatively placed here. They both differ from the typical form in having gland appendages that are not as toothed or lobed, and more prominent seed sculpturing. These variants warrant further collecting and investigation.

51. Euphorbia thelephora Halford & W.K.Harris, **species nova** saepe cum *E. inappendiculata* Domin confusa sed stylis integris (ad vicem stylis 1/2–2/3 longitudinis plerumque capsulis longioribus), 1.5–2 mm longis (ad vicem capsulis 1.3–1.6 mm longis), distincte papillosis (ad vicem capsulis tantum aliquando minute papillosis), seminibus plerumque longioribus 1.3–1.7 mm longis (ad vicem seminibus 0.9–1.3 mm longis) differt. **Typus:** Queensland. Burke District: 83 km S of Normanton on road to Cloncurry, 1 August 2011, *D.Halford QM515* (holo: BRI; iso: AD, DNA, MEL, MICH, NSW, P, *distribuendi*).

Monoecious or dioecious, herbaceous perennial to 30 cm high, few to many annual stems arising from woody rootstock. **Stems** prostrate, decumbent or erect, sparingly to much branched, smooth or papillose, with a sparse to dense indumentum (rarely glabrous); hairs spreading, ± straight, 0.1–1.5 mm long, white. **Interpetiolar stipules** subulate, 0.3–1.3 mm long, bipartite, papillose, glabrous or hairy as for stems; margin entire or laciniate. **Leaves**: petiole 0.3–1 mm long, papillose (rarely smooth), indumentum as for stems; blade oblong, obovate, elliptic or oblong-elliptic to rotund, 2–8 mm long, 1–6 mm wide, 1–2.4 times longer than wide; adaxial surface green, grey-green, sometimes with reddish tinge along margin, smooth or papillose, glabrous or with a sparse to dense indumentum consisting of spreading, straight to curved hairs 0.1–0.8 mm long; abaxial surface green or pale, papillose; glabrous or with a indumentum as for adaxial surface; base asymmetric with one side cordate, the other rounded to obtuse; margin entire or obscurely toothed distally; apex rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles 0.2–0.5 mm long, papillose, indumentum as for stems. **Involucres** cupuliform or turbinate, 0.7–1.4 mm long, 0.7–1.4 mm across; lobes 5, triangular, 0.3–0.6 mm long, margin entire or ciliate; glands 4, stipitate, patelliform, planar to shallowly concave, or cupuliform with distinct tangential trough and thickened rim, transverse-oblong, orbicular or reniform in outline, 0.1–0.3 mm long; 0.2–0.5(0.9) mm wide, red or yellow; gland appendages conspicuous to inconspicuous or absent, spreading radially, transverse-oblong or triangular, 0.05–0.4 mm long, 0.05–1.1 mm wide, white or red, glabrous, margin entire or lobed; bracteoles 0.6–1 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into few to many subulate, glabrous or hirsute segments. **Staminate**

flowers 1–13 per cyathium; pedicels 0.6–1.2 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles (0.2)0.3–1.1 mm long, spreading, recurved distally, smooth or papillose abaxially, glabrous or sparsely hairy proximally, entire, the apices terete. **Capsules** exserted from involucre on pedicel to 2.3 mm long, elliptic to broad-elliptic in lateral view, 1.5–2.2 mm long, 1.2–1.8 mm across, shallowly 3-lobate with keels acute to obtuse, papillose rarely smooth, glabrous or with a sparse to dense indumentum consisting of spreading hairs to 0.5 mm long; hypogynous disc entire. **Seeds** narrow-ovate or ovate, 1.2–1.7 mm long, 0.5–0.8 mm tangentially, 0.5–0.7 mm radially, tetraquetrous in cross section; dorsal faces ± planar, smooth or with numerous, prominent, narrow rounded ± transverse ridges or with a single medial longitudinal ridge; ventral faces planar to concave, smooth or with numerous, prominent, narrow rounded ± transverse ridges; exotesta thin, of even thickness over surface or of uneven thickness and distinctly thicker on ridges, grey-white, pale brown, microreticulate, becoming mucilaginous when moistened; endotesta brown to red-brown.

Distribution and habitat: *Euphorbia thelephora* occurs from the Barkly Tableland, NT, eastward to Normanton, Qld and south to Coober Pedy, SA and east to Tibooburra in far north-western NSW.

Notes: *Euphorbia thelephora* has been confused with *E. inappendiculata*. It differs from that species by having styles entire (versus styles bifid for 1/2–2/3 of their length), generally longer capsules (1.5–2 mm long versus capsules 1.3–1.6 mm long for *E. inappendiculata*) which are distinctly papillose (versus capsules only occasionally minutely papillose for *E. inappendiculata*), and generally longer seeds (1.3–1.7 mm long versus 0.9–1.3 mm long for *E. inappendiculata*).

Etymology: The specific epithet is from Greek *thelephorus*, bearing nipple-like projections, in reference to the papillate surface on the capsules and leaves in the typical form of this species.

Notes: *Euphorbia thelephora* varies in attributes of its indumentum and seeds. On this basis, three varieties are formally recognised here and can be distinguished using the following key.

Key to varieties of *Euphorbia thelephora*

1 Seeds with transverse ridges . . . . **51c. E. thelephora** var. **rugosa**
1. Seeds smooth or finely granulate **2**

2 Leaves and capsules glabrous or with a few scattered hairs **51a. E. thelephora** var. **thelephora**
2. Leaves and capsules sparsely to densely hairy . . . . **51b. E. thelephora** var. **australis**

51a. Euphorbia thelephora var. thelephora

Euphorbia sp. Beddome Range (D.E.Albrecht 5656); Short *et al.* (2011: 31).

Stem glabrous or with a sparse indumentum of spreading hairs to 0.5(1) mm long. **Leaves** with adaxial and abaxial surfaces glabrous or rarely with a few scattered spreading hairs to 0.3 mm long. **Involucres** turbinate, 0.7–0.8 mm long, 0.7–0.9 mm across; glands patelliform, planar or shallowly concave, transverse-oblong or orbicular in outline, 0.1–0.3 mm long, 0.2–0.5 mm wide, yellow; gland appendages inconspicuous or absent, to 0.2 mm long, 0.05–0.2 mm wide, white. **Staminate flowers** 1–4 per cyathium. **Capsules** elliptic in lateral view, papillose, glabrous or rarely with a few scattered spreading hairs to 0.3 mm long. Seeds narrow-ovate, dorsal and ventral faces smooth. $n = 11$. **Figs 20, 28C.**

Additional selected specimens examined: **Northern Territory.** 2 miles [*c.* 3.2 km] W [of] Avon Downs, Jun 1960, *Chippendale 7262* (AD, BRI, DNA, MEL); 10 km N of Brunette Downs turnoff on Borroloola Road, Sep 1978, *Farrell TF901* (BRI); *c.* 12 miles [*c.* 19 km] W of Camooweal, Jul 1974, *Hassall 7448* (BRI); James River

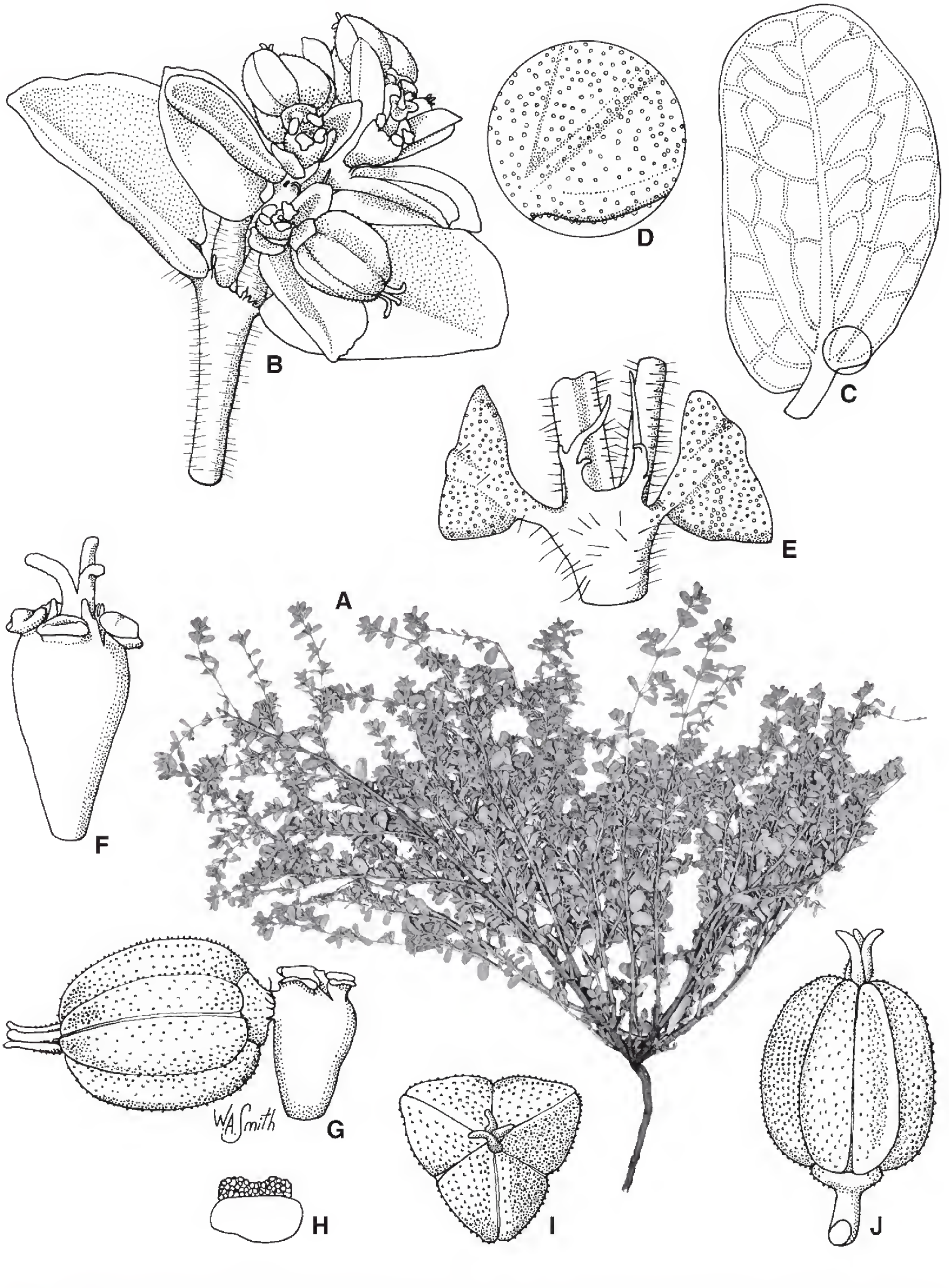

Fig. 20. ***Euphorbia thelephora*** *var.* ***thelephora***. A. habit ×0.4. B. branchlet with cyathia ×8. C. leaf ×8. D. papillae on lower leaf surface ×32. E. stipules ×16. F. cyathia with female flower ×24. G. capsule with cyathia ×16. H. cyathial gland with appendage, adaxial view ×32. I. capsule, top view ×16. J. capsule, lateral view ×16. A, C–E from *Chippendale 7262* (BRI); B, F–J from *Halford Q8602 & Thomas* (BRI). Del. W.Smith.

at crossing, Barkley Highway, Avon Downs, Jun 1968, *Nicholls 860* (NT); Beddome Range, New Crown Station, Nov 1993, *Albrecht 5656* (BRI, DNA, NT); Beddome Range, May 1974, *Latz 5232* (BRI). **Queensland.** Burke District: 8 km S of Normanton, May 1976, *Hassall 7634* (BRI); 16 km SE of Leichhardt Falls on the Burketown – Donors Hill Road, Apr 1974, *Pullen 8939* (BRI); *c.* 20 km W [of] Undilla, Burketown – Camooweal Road, May 1990, *Latz 11640* (DNA); Hughenden – Mt Isa Road, *c.* 99 km W of Julia Creek, Apr 1975, *Halliday 421* (BRI); 'Somerville', 50 miles [*c.* 80 km] NE of Maxwelton, May 1963, *Entwistle 3* (BRI). Gregory North District: 33 km N of Boulia, May 1976, *Hassall 7646* (BRI); 130 km W of Winton on road to Boulia, Sep 2005, *Halford Q8602 & Thomas* (BRI); 5 km WNW of 'Red Hill', Jun 1978, *Purdie 1228* (BRI); 27 km WNW of 'Marion Downs', Sep 1978, *Purdie 1436* (BRI); 124 km ESE of Bedourie, May 1976, *Hassall 7656* (BRI); Diamantina N.P., N boundary of park, Apr 1997, *Forster PIF20755 & Holland* (BRI). Gregory South District: 18 miles [*c.* 29 km] NE of Betoota, May 1975, *Hassall 7519* (AD, BRI); 70 km NW of Monkira homestead, May 1985, *Neldner 1870 & Stanley* (BRI). **South Australia.** Pandie Pandie Station, gibber plain 3.5 km S of Lake Moorayepe, June 1983, *Alexander 2277* (AD); Pedirka, Aug 1932, *Ising 3012* (AD); 5 km S of Copper Hill Station homestead, Aug 1992, *Badman 5972* (AD).

***Distribution and habitat*:** *Euphorbia thelephora* var. *thelephora* occurs from the Barkly Tableland, NT, eastward to Normanton, Qld, and south to Coober Pedy, SA and into north-western NSW (**Map 51a**). It commonly grows in *Dichanthium*/*Astrebla* grassland, *Atalaya* and *Grevillea* woodland or *Acacia cambagei* R.T.Baker tall shrubland, on stony clay or cracking clay soils on undulating plains. The variety also inhabits *Eucalyptus camaldulensis* Dehnh. low open woodland along drainage lines, open grassland and woodland on the slopes of small mesas or low stony hills.

51b. Euphorbia thelephora var. **australis** Halford & W.K.Harris, **varietas nova** ab *E. thelephora* var. *thelephora* indumento caulium foliorumque pilis sparsis usque densis (ad vicem glabris vel pilis paucis dispersis), floribus staminibus 5–13 in quoque cyathio (ad vicem floribus staminibus 1–4 in quoque cyathio) necnon ab *E. thelephora* var. *rugosa* seminis superficie laevi (ad vicem superficie porcis ± transversis multis prominentibus angustis rotundatis praedito) differt. **Typus:** Queensland. Gregory North District: *c.* 20 km E along Donahue Highway from Qld/NT border, W of Boulia, 15 October 2011, *D.Halford QM604* (holo: BRI, iso: AD, DNA, MICH, NSW, *distribuendi*).

Stem with a sparse to dense indumentum of spreading hairs to 0.8 mm long. **Leaves**: adaxial and abaxial surfaces with a sparse to dense indumentum of spreading hairs to 0.8 mm long. **Involucres** turbinate, cupuliform, 0.8–1.4 mm long, 1–1.4 mm across; glands patelliform, planar to shallowly concave or rarely cupuliform with distinct tangential trough, transverse-oblong or reniform in outline, 0.1–0.3 mm long; 0.3–0.5(0.9) mm wide, red or yellow; gland appendages conspicuous or absent, transverse-oblong, 0.1–0.4 mm long, 0.4–0.5(1.1) mm wide, white or red. **Staminate flowers** 5–13 per cyathium. **Capsules** elliptic to broad-elliptic in lateral view, papillose (rarely smooth), densely hairy with weakly spreading hairs 0.3–0.5 mm long. Seeds narrow-ovate to ovate, dorsal and ventral faces smooth. **Fig. 28D.**

***Additional selected specimens examined*:** **Northern Territory.** Horseshoe Bend Road, 5 km N of Lilla Creek, Aug 1988, *Barritt 776* (DNA [mixed collection with *E. thelephora* var. *rugosa*]). **Queensland.** Burke District: Silver Hills, 15 km N of Richmond, Apr 1977, *Farrell TF807* (BRI). Gregory North District: Roxborough Downs, Jan 1896, *Bailey s.n.* (BRI [AQ202490]) [mixed collection with *E. thelephora* var. *rugosa*]. **South Australia.** 14 km E of Roxby Downs homestead, Apr 1989, *Badman 2032* (AD); 8 km SE of Netting Dam, Arm of Lake Torrens, Andamooka Station, Jul 1989, *Badman 3247* (AD); 1 km S of homestead, Muloorina Station, Apr 1996, *Badman 8903* (AD); *c.* 8 km NE of Koonamore, Curnamona Road, Apr 1968, *Barker 351* (AD); Borefield Road, Apr 1997, *Bates 46870* (AD); Waukaringa Gold Mine, 30 km N of Yunta, Oct 1968, *Carrick 1724* (AD); Beresford Hill, Oct 1978, *Chorney 992* (AD [mixed collection with *E. centralis*], NSW); Bongadillina Creek, Warrina, 130 km N of William Creek, Jun 1985, *Conrick 1801* (AD); *c.* 10 km SSW of Mt Gunson Copper Mines W of Pernatty Lagoon, Oct 1966, *Eichler 18833* (AD); picnic ground *c.* 6 miles (*c.* 9 km) W of Marree, Jul 1955, *Hill 100* (AD); Evelyn Downs, Oct 1955, *Ising s.n.* (AD 966150240); *c.* 22 km of Stuart Creek crossing (near Blower Waterhole) on track to Coward Springs from Stuart Creek homestead, Mar 1984, *Jackson 5147* (AD); Mt Lyndhurst, Oct 1898, *Koch 245* (AD); Carriewerloo Station, 3 km E of homestead, Jun 1992, *Michael 353* (AD); Carriewerloo Station, 1 km NW of SE corner of Horseshoe paddock, Mar 1993, *Michael 536* (AD); *c.* 2 km NE of Gordon, *c.* 16 km SW of Hawker, Oct 1958, *Schodde 965* (AD); Dalhousie, Jun 1987, *Symon 14569b* **New South Wales.** 18.6 km N of Tibooburra on Silver City Highway in Sturt N.P., Sep 1989, *Coveny 13612 et al.* (NSW).

***Distribution and habitat*:** *Euphorbia thelephora* var. *australis* extends from near Finke, NT, south east to near Yunta, SA, with disjunct populations in western NSW and north-western Qld (**Map 51b**). It grows in herbland communities on clayey loam or clay soils on gibber plains, in low open shrubland communities on skeletal clay soils on rocky calcareous/gypseous hills, or in loam or sandy clay soils on alluvial flats or creek banks.

***Phenology*:** Flowers and fruits have been collected in January, March to October.

***Notes*:** *Euphorbia thelephora* var. *australis* differs from *E. thelephora* var. *thelephora* by having a sparse to dense indumentum on its stems and leaves (versus glabrous or with a few scattered hairs for *E. thelephora* var. *thelephora*) and 5–13 staminate flowers per cyathium (versus 1–4 staminate flowers for *E. thelephora* var. *thelephora*). *Euphorbia thelephora* var. *australis* differs from *E. thelephora* var. *rugosa* by having a smooth seed surface (versus seed surface with numerous prominent narrow rounded ± transverse ridges).

***Etymology*:** The varietal epithet is Latin *australis*, south, southern, in reference to this variety's distribution in relation to that of the other varieties of this species.

51c. Euphorbia thelephora var. **rugosa** Halford & W.K.Harris, **varietas nova** ab aliis varietatibus *E. thelephorae* seminis superficie porcis ± transversis multis prominentibus angustis rotundatis praedita (ad vicem superficie laevi) necnon ab *E. thelephora* var. *thelephora* indumento caulium foliorumque sparso usque denso (ad vicem glabro vel pilis paucis dispersis) et floribus staminatis 7–10 in quoque cyathio (ad vicem floribus staminatis 1–4 in quoque cyathio) differt. **Typus:** Northern Territory. 5 km W along Hatt Road from Stuart Highway, S of Alice Springs, 18 October 2011, *D.Halford QM614* (holo: BRI; iso: AD, DNA, MEL, MICH, *distribuendi*).

Stem with a dense indumentum of spreading hairs to 0.8 mm long. **Leaves**: adaxial and abaxial surfaces with a dense indumentum of spreading hairs to 0.8 mm long. **Involucres** cupuliform, 0.8–1.4 mm long, 0.9–1.4 mm across; glands cupuliform, with distinct tangential trough and thickened rim, transverse-oblong in outline, 0.2–0.3 mm long; 0.3–0.5 mm wide, red; gland appendages conspicuous, transverse-oblong, 0.2–0.3 mm long, 0.6–1 mm wide, pink to red. **Staminate flowers** 7–10 per cyathium. **Capsules** elliptic in lateral view, papillose (rarely smooth), densely hairy with weakly spreading hairs 0.3–0.5 mm long. Seeds narrow-ovate to ovate, dorsal and ventral faces with numerous prominent narrow rounded ± transverse ridges. $n = 11$. **Fig. 28E**.

***Additional selected specimens examined*:** **Northern Territory.** Manners Creek homestead, Sep 1954, *Chippendale 390* (NSW); 5 km W of Stuart Highway, road to Pine Gap, Dec 1993, *Albrecht 5728* (NT); *c.* 4 km NW Mt Ebenezer homestead, Oct 1992, *Nelson 2860* (DNA); Horseshoe Bend Road, 5 km N of Lilla Creek, Aug 1988, *Barritt 776* (DNA) [mixed collection with *E. thelephora* var. *australis*]. **Queensland.** GREGORY NORTH DISTRICT: *c.* 73 km S of Cloncurry, May 1976, *Hassall 7643* (BRI); Roxborough Downs, Jan 1896, *Bailey s.n.* (BRI [AQ202490]) [mixed collection with *E. thelephora* var. *australis*]; Glenormiston, 10 miles [*c.* 16 km] W of homestead, Aug 1949, *Colliver s.n.* (BRI [AQ202489]); 23 km NE of Old Cork homestead, near Diamantina River, Nov 1986, *Neldner 2599 & Nicolson* (BRI); Currawilla, *c.* 100 miles [*c.* 161 km] W of Windorah, Jun 1949, *Everist 3913* (BRI); Georgina River, Sep 1910, *Bick 101* (BRI). **South Australia.** Dalhousie, Jun 1987, *Symon 14568* (AD); Macumba, *s.d.*, *Tate 126* (AD).

***Distribution and habitat*:** *Euphorbia thelephora* var. *rugosa* occurs in central Australia from Mt Ebenezer, in southern NT and Macumba, in northern SA, north east to the Diamantina River, in western Qld (**Map 51c**). It grows in *Acacia* shrubland or woodland communities on sandy loam, clay loam or stony clay soils on plains or low calcareous hills.

***Phenology*:** Flowers and fruits have been recorded in January, May, June, and from August to November.

***Notes*:** *Euphorbia thelephora* var. *rugosa* differs from the other varieties of *E. thelephora* by having a seed surface with numerous prominent narrow rounded ± transverse ridges (versus smooth seed surface for the other *E. thelephora* varieties). *Euphorbia thelephora* var. *rugosa* also differs from *E. thelephora* var. *thelephora* by having a sparse to dense indumentum on its stems and leaves (versus glabrous or with a few scattered hairs for *E. thelephora* var. *thelephora*) and 7–10 staminate flowers per cyathium (versus 1–4 staminate flowers for *E. thelephora* var. *thelephora*).

***Etymology*:** The varietal epithet is from Latin *rugosus*, wrinkled, in reference to the seed surface texture of this variety.

52. *Euphorbia thymifolia L., *Sp. Pl.* 1: 454 (1753); *Chamaesyce thymifolia* (L.) Millsp., *Publ. Field Mus., Bot. Ser.* 2(11): 412 (1916). **Type:** "habitat in India" (lecto: LINN [*Herb. Linn. No. 630.10*] *n.v.* (IDC microfiche 177. 320: III. 3), *fide* Wheeler [1941: 253]).

***Illustration*:** Lin *et al.* (1991: 248, fig. 20), as *Chamaesyce thymifolia*.

Monoecious, herbaceous perennial, with many annual stems arising from crown of slender taproot. **Stems** prostrate, much branched, smooth, with a moderately dense indumentum on upper surface; hairs appressed to ascending, crispate, to 0.4 mm long, white. **Interpetiolar stipules** subulate, 0.5–1.3 mm long, bipartite, indumentum as for stems; margin laciniate. **Leaves**: petiole 0.8–1 mm long, smooth, glabrous or with a few scattered hairs; blade oblong to ovate, elliptic or oblong-elliptic, 5–8 mm long, 2.5–5 mm wide, 1.6–1.8 times longer than wide; adaxial surface green to blue green, occasionally red, smooth, glabrous; abaxial surface pale green, smooth, with a sparse to moderately dense indumentum consisting of appressed-ascending, crispate hairs 0.3–0.4 mm long; base asymmetric with one side rounded to shallowly cordate, the other obtuse to rounded; margin serrulate, sometimes only distally; apex rounded. **Cyathia** solitary at the nodes, but often clustered on short leafy axillary branchlets with subtending leaves usually much smaller than primary stem leaves; peduncles 0.2–0.5 mm long, smooth, glabrous. **Involucres** turbinate, 0.5–0.8 mm long, *c.* 0.5 mm across; lobes 5, triangular, *c.* 0.2 mm long, margin fimbriate; glands 4, stipitate, patelliform, shallowly concave, transverse-oblong to transverse-elliptic in outline, *c.* 0.1 mm long, 0.2–0.3 mm wide, red; gland appendages inconspicuous, spreading radially, transverse-oblong or obdeltoid, *c.* 0.1 mm long and 0.2 mm wide, white to pink, glabrous, margin entire or shallowly lobed; bracteoles 0.5–0.6 mm long, adnate for *c.* 1/5 of their length to involucre, free portion divided into ± linear hairy segments. **Staminate flowers** 3–5 per cyathium; pedicels 0.7–0.8 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.7 mm long, spreading, smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** at maturity on pedicel 0.5–0.6 mm long, not completely exserted from involucre, rupturing side of involucre, broad to very broad-ovate in lateral view, *c.* 1 mm long, 1–1.1 mm across, shallowly 3-lobate with keels acute, smooth, with a moderately dense indumentum; hairs appressed, 0.1–0.2 mm long; hypogynous disc entire. **Seeds** ovate in outline, 0.6–0.8 mm long, 0.4–0.5 mm tangentially, 0.4–0.5 mm radially, tetraquetrous in cross section; dorsal and ventral surfaces concave with 3 or 4 distinct, narrow, rounded, transverse ridges; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown. **Fig. 28F.**

***Additional selected specimens examined*:** **Western Australia.** Broome, May 1991, *Thomson 3481* (NT). **Northern Territory.** Palmerston, Driver High School, Jan 1995, *Cowie 5179* (BRI, MEL); Howard Springs Nature Park, Jun 1984, *Rankin 2961* (DNA). **Queensland.** COOK DISTRICT: Injinoo, Mar 1993, *Waterhouse BMW2813* (BRI); Heathlands, Mar 1992, *Johnson 5199 & Sharpe* (BRI); Beames Street, Mareeba, Apr 1983, *Clarkson 4597* (BRI); Cowley Beach, Feb 1978, *Hopkins 1511 & Graham* (BRI). BURKE DISTRICT: Gregory River crossing, Riversleigh Station, May 1990, *Latz 11638* (DNA). NORTH KENNEDY DISTRICT: Townsville, Feb 1980, *Stanley 8051* (BRI); Bowen, Delta Horticultural Research Station, Jul 1980, *Swarbrick WNA28* (BRI). SOUTH KENNEDY DISTRICT: edge of Eungella Dam, W of Eungella, Feb 2003, *Bean 20068 & Champion* (BRI). PORT CURTIS DISTRICT: Mt Morgan Railway Station, Nov 2004, *Batianoff 0411545 & Halford* (BRI). MORETON DISTRICT: 2 Orion Court, Rothwell, northern suburb of Brisbane, Mar 2007, *Austin s.n.* (BRI [AQ790414]).

***Distribution and habitat*:** *Euphorbia thymifolia* is most likely native to the New World, but has become widely naturalised in the Old World tropics. In Australia it has become naturalised in the coastal tropical and subtropical regions of Qld with isolated occurrences in Broome, WA, the Darwin region, NT and Riversleigh Station, north-western Qld (**Map 52**). It grows mostly in sunny situations on disturbed ground, lawns, garden beds, and is frequently recorded growing along pathways.

Phenology**:** Flowers and fruits have been recorded from November to August.

Notes**:** *Euphorbia thymifolia* may be confused with another two introduced weedy species, *E. maculata* and *E. prostrata*. It is distinguished from both of these species in having generally smaller capsules and seeds, longer and more divided style limbs, and the capsules on short pedicels at maturity causing the involucre to split.

53. Euphorbia trigonosperma Halford & W.K.Harris, **species nova** similis *E. biconvexae* Domin et *E. coghlanii* F.M.Bailey sed seminibus trigonis transversaliter (ad vicem seminibus lenticularibus in *E. biconvexa* et suborbicularibus in *E. coghlanii*) differt. **Typus:** Queensland. COOK DISTRICT: eastern flank of Newcastle Range, W of Mount Surprise, 27 December 2006, *K.R.McDonald KRM6016* (holo: BRI).

Euphorbia mitchelliana var. *glauca* Benth., *Fl. Austral.* 6: 47 (1873). **Type:** [Western Australia.] Nickol Bay, [in 1861,] Gregory Expedition [*P.Walcott s.n.*] (lecto [here designated]: MEL 1560383).

Euphorbia sp. Hale River (B.G. Thomson 3395); Short *et al.* (2011: 31).

Monoecious, herbaceous perennial to 50 (100) cm high, few stems arising from slender woody taproot. **Stems** mostly erect or sometimes decumbent to ascending, sparingly to much branched, smooth, with a sparse to moderately dense indumentum or glabrous; hairs spreading, ± straight, 0.2–0.5 mm long, white. **Interpetiolar stipules** narrow-triangular, 0.8–1.4 mm long, entire, bifid or bipartite, glabrous; margin entire. **Leaves**: petiole 0.8–1.2 mm long, smooth, glabrous; blade narrow-oblong or ovate, sometimes falcate, 12–30 mm long, 4–13 mm wide, 1.6–4.2 times longer than wide; adaxial surface light to dark green or grey green, smooth (rarely minutely papillose), glabrous; abaxial surface paler than adaxial surface, smooth (rarely minutely papillose), glabrous or (rarely with scattered spreading hairs *c.* 1 mm long); base asymmetric or symmetric with one side cordate, the other rounded or cordate; margin entire or sparingly minutely or coarsely toothed; apex rounded, obtuse or acute. **Cyathia** solitary at the nodes, but mostly clustered in congested monochasial or dichasial cymes on shortened axillary branchlets with subtending leaves much smaller primary stem leaves; cyathial peduncles 1–10 mm long. **Involucres** campanulate or turbinate, 1–1.8 mm long, 0.9–2 mm across; lobes 5, triangular to subulate, 0.4–1.1 mm long, margin laciniate; glands 4, stipitate, patelliform, planar, transverse-oblong or orbicular in outline, 0.2–0.4 mm long, 0.2–1 mm wide, green or yellowish green; gland appendages conspicuous (rarely absent), spreading radially, transverse-elliptic or very broad-obovate, 0.1–1.6 mm long, 0.4–2.3 mm wide, white, pink or yellowish-white, glabrous, margin entire; bracteoles 1–1.5 mm long, adnate for 1/2–2/3 of their length to involucre, free portion divided into numerous subulate glabrous segments. **Staminate flowers** 2–32 per cyathium; pedicels 0.9–2.2 mm long; staminal filaments 0.3–0.6 mm long. **Pistillate flowers**: styles 0.8–1.5 mm long, connate at the base into a column for up to 1/5 of their length, spreading, sometimes recurved distally, smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 4 mm long, elliptic in lateral view, 1.5–2.1 mm long, 1.9–2.6 mm across, deeply 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** ovate or elliptic in outline, (1)1.2–1.6 mm long, 0.6–1 mm tangentially, 0.8–1 mm radially, trigonal in cross section; dorsal faces convex, smooth; ventral faces planar or convex, smooth; exotesta thin, of even thickness over surface, pale brown, microreticulate, becoming mucilaginous when moistened; endotesta dark brown. **Figs 21, 28G.**

Additional selected specimens examined**: Western Australia.** block 16 along track next to main channel, Kununurra, Mar 1978, *Aplin 6315* (BRI, PERTH); 6 km SW of Mt Chalmers and 26 km from Dog Chain Creek on road to Derby, Jun 1988, *Wilson 12931* (PERTH); 86 km NE of Sandfire Roadhouse, Great Northern Highway, Sep 1978, *Beauglehole ACB59231 & Errey* (PERTH); Munda Creek, Mundabullangana Station, W of Port Hedland, Feb 1962, *George 3369* (PERTH); Gregory Gorge, W Millstream, May 1976, *Keighery 738* (PERTH); Hamersley Range N.P., first hill on east side of road to Hancock Gorge from Mt Bruce – Mt Tom Price Road, May 1980, *Trudgen 2688* (PERTH); 33 miles [*c.* 53 km] N of Carnarvon on road to Quobba, Feb 1962, *George 3255* (PERTH). **Northern Territory.** Gregory N.P., Feb 1992, *Cowie 2212 & Brocklehurst* (MEL); Gold Creek, Wollogorang, Jan 1989, *Russell-Smith 6890 & Lucas* (DNA); Upper Robinson River, Jan 1989, *Thomson 3060* (BRI, DNA); Birrindudu, Jun 1994, *Egan 3776* (DNA); 26 km NW Barkly homestead, Apr 1993, *Parsons 388* (DNA); 13 km SSE [of] Sangsters Bore, Tanami Desert, Jun 1991, *Latz 11958* (MEL); Amarata Waterhole, Hale River, Nov 1989, *Thomson 3395* (DNA). **Queensland.** BURKE DISTRICT: 34.6 km SW of Hells Gate Roadhouse, turn off Lagoons, Apr 2006, *Thompson WES292 & Edginton* (BRI); Lawn Hill N.P., Musselbrook section, Murray Springs, Apr 2003, *Booth 3205 & Kelman* (BRI); E of Jump-up, 33.6 km (by road) E of Musselbrook Mining Camp, May 1995, *Johnson MRS1028 & Thomas* (BRI); 30 miles [*c.* 48 km] SE of Riversleigh Station, Jun 1948, *Perry 1428* (DNA); 11 km N and 2 km W of Mt Isa, Jun 1983, *Schmid 654* (BRI); *c.* 7 km NW of Croydon, just W of Welcome Creek, Dec 1998, *Wannan 980* (BRI); 14.9 km by road from Georgetown towards Forsyth, Feb 2006, *McDonald KRM4841* (BRI). **South Australia.** Christmas Creek near Crispe Bore, May 1987, *Symon 14390* (AD).

Distribution and habitat**:** *Euphorbia trigonosperma* occurs across northern Australia from the Pilbara and Kimberley, WA, extending through the northern central area of NT, and eastward to north-western Qld, with outlying occurrences in southern NT and far northern SA (**Map 53**). It grows in grassland, shrubland or woodland communities, in sandy soils on coastal or inland dunes, in well-drained sandy soils on stony slopes of sandstone or limestone hills, and in sandy alluvium along drainage lines.

Phenology**:** Flowers and fruits have been collected throughout the year, particularly from January to September.

Notes**:** *Euphorbia trigonosperma* seems most closely related to *E. biconvexa* and *E. coghlanii*. It differs from both species in having seeds that are trigonous in transverse section (versus lenticulate for *E. biconvexa* and suborbicular for *E. coghlanii*), larger involucral glands (0.2–0.4 × 0.2–1 mm versus 0.1–0.2 × 0.1–0.6 mm for *E. biconvexa* and *E. coghlanii*) and longer styles (0.8–1.5 mm long versus 0.4–0.8 mm for *E. biconvexa* and *E. coghlanii*).

This species as circumscribed here varies considerably in the shape and thickness of its leaf blades, number of staminate flowers per cyathia and size of its gland appendages. Further collections and field studies are warranted to establish the significance of this variation.

54. Euphorbia vaccaria Baill., *Adansonia* 6: 286 (1866). **Type:** [Western Australia.] Hierson Island, Nickol [Nichol] Bay, *s.d.*, *P.Walcott s.n.* (lecto: MEL 1551017, *fide* Thomson [1992: 354]; isolecto: P 313104).

Monoecious, herbaceous perennial to 2 cm high, with many annual stems arising from a thickened woody taproot. **Stems** prostrate, sparingly to much branched, smooth, with a sparse to moderately dense indumentum; hairs spreading, ± straight, 0.8–1.8 mm long, white. **Interpetiolar stipules** narrow-triangular, 0.7–0.8 mm long, deeply bipartite, with indumentum as for stems; margin laciniate. **Leaves**: petiole 1–1.5 mm long, smooth, with indumentum as for stems; blade oblong, oblong-elliptic, ovate or obovate, 4–9 mm long, 1.5–4 mm wide, 1.2–2.5 times longer than wide; adaxial and abaxial surfaces pale green to green, smooth, with moderately dense to dense indumentum consisting of ascending to spreading, straight hairs 0.3–1 mm long; base asymmetric with one side truncate, cordate to obtuse, the other cuneate to obtuse or rounded; margin entire or minutely toothed distally; apex obtuse to rounded. **Cyathia** solitary at the nodes, often clustered on short leafy lateral branchlets with subtending leaves slightly smaller than primary stem leaves; peduncles 0.2–1.2 mm long, smooth, hairy. **Involucres** campanulate, 1.3–2 mm long, 0.8–1.4 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin entire; glands 4, stipitate, cupuliform, with tangential trough, transverse-oblong in outline, 0.1–0.2 mm long, 0.2–0.4 mm wide, dark red; gland appendages conspicuous, spreading radially,

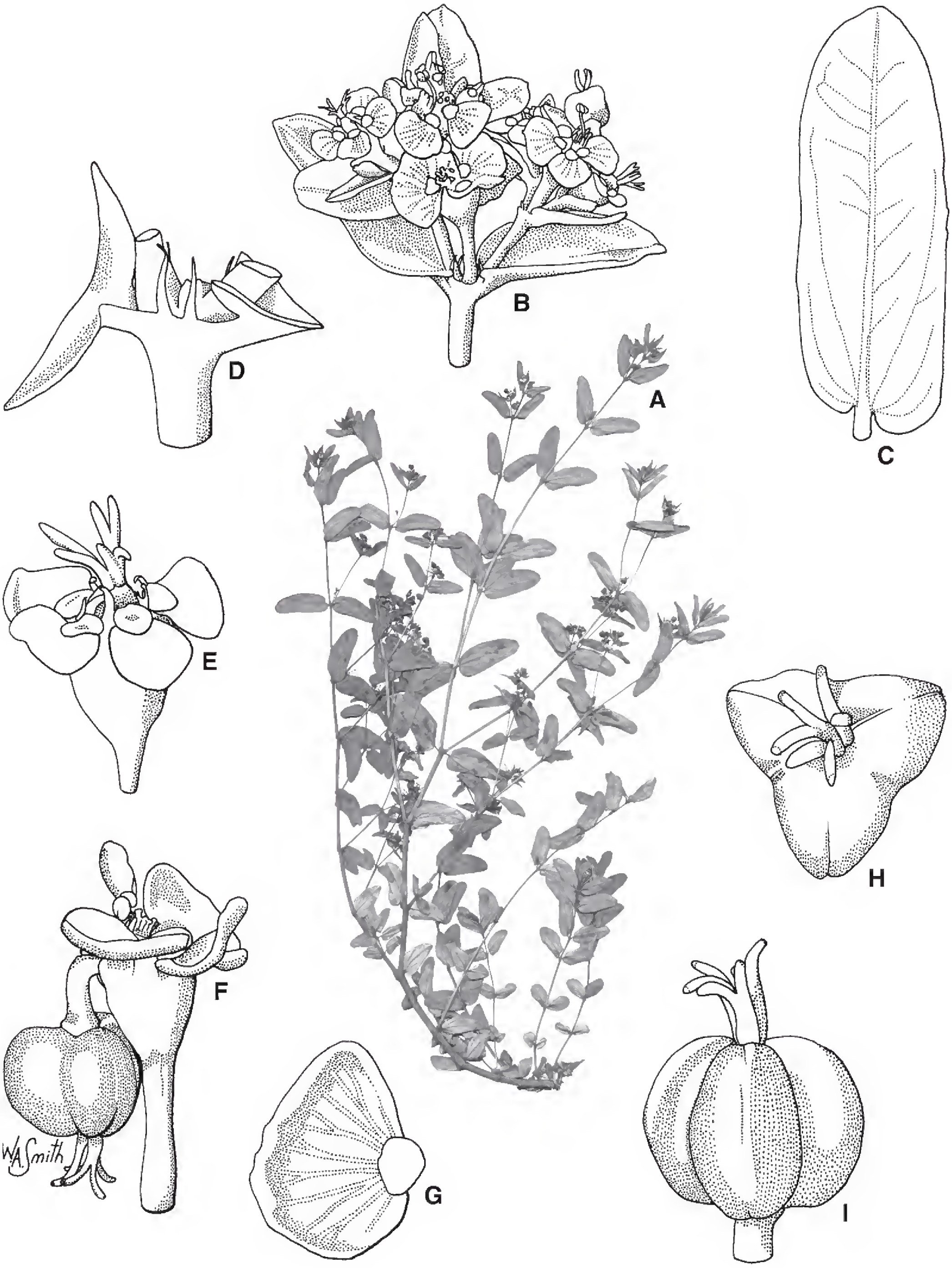

Fig. 21. ***Euphorbia trigonosperma***. A. habit ×0.4. B. branchlet with cyathia ×4. C. leaf ×2. D. stipules ×8. E. cyathia with female flower ×12. F. cyathia with immature capsule ×8. G. cyathial gland with appendage, adaxial view ×12. H. capsule, top view ×12. I. capsule, lateral view ×12. A from *McDonald KRM6016* (BRI); B–I from *Thompson WES292 & Edginton* (BRI). Del. W.Smith.

obdeltoid, 0.3–0.5 mm long, 0.6–1 mm wide, pink, red or white, glabrous, margin toothed or irregularly lobed; bracteoles 0.6–0.8 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into ± linear hairy or glabrous segments. **Staminate flowers** 3–5 per cyathium; pedicels 1.2–1.6 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.3–0.5 mm long, ascending and spreading distally, minutely papillose, glabrous, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, broad to very broad-ovate in lateral view, 1.3–1.7 mm long, 1.2–1.9 mm across, shallowly 3-lobate with keels obtuse, smooth or minutely papillose, with a dense indumentum mostly confined to the proximal half of the capsule; hairs spreading, to 1.5 mm long; hypogynous disc entire. **Seeds** ovate in outline, 0.8–1.2 mm long, 0.5–0.9 mm tangentially, 0.5–0.8 mm radially, tetraquetrous in cross section; dorsal faces ± planar or slightly concave, with faint narrow rounded irregular ridges; ventral faces concave, ± smooth; exotesta thin, of even thickness over surface, grey-white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta pale brown or reddish brown.

Distribution and habitat: *Euphorbia vaccaria* occurs from near Onslow, WA east to Victoria River Crossing and the Tanami Desert, NT.

Notes: *Euphorbia vaccaria* is similar to and often grows with *E. australis* var. *subtomentosa* where their distributions overlap. *Euphorbia vaccaria* differs from *E. australis* by the indumentum of the capsules being confined to the proximal half of the capsule and consisting of hairs 0.8–1.5 mm long (versus hairs evenly disturbed over the capsule surface and consisting of hairs up to 0.7 mm long for *E. australis*).

Euphorbia vaccaria exhibits some discontinuous variation in indumentum and leaf characters with little geographical discontinuity. This variation is considered sufficient to warrant formal recognition of two varieties within this species which can be distinguished using the following key.

Key to varieties of *Euphorbia vaccaria*

Leaves subtending cyathia on short lateral branchlets entire or minutely toothed; indumentum 0.8–1 mm long . . . . **54a.E. vaccaria** var. **vaccaria**

Leaves subtending cyathia on short lateral branchlets distinctly toothed distally; indumentum 1–1.8 mm long. . . . . **54b. E. vaccaria** var. **erucoides**

54a. Euphorbia vaccaria var. vaccaria

Stems prostrate, with a moderately dense indumentum; hairs 0.8–1 mm long. **Leaf blades** oblong, ovate or obovate, 4–8 mm long, 2–4 mm wide, 1.6–2.5 times longer than wide; adaxial and abaxial surfaces with a moderately dense indumentum of hairs 0.3–1 mm long; base asymmetric with one side truncate to shallowly cordate, the other rounded; margin entire or minutely toothed distally; apex obtuse to rounded. **Involucral gland appendages** 0.1–0.4 mm long, *c.* 0.5 mm wide, pink, red or white, margin toothed or irregularly lobed. **Pistillate flowers** with styles 0.3–0.4 mm long. **Capsules** exserted from involucre on pedicel to 2.5 mm long, 1.3–1.7 mm long, 1.2–1.7 mm across, hairs to 0.8 mm long. **Fig. 28H.**

Additional selected specimens examined: **Western Australia.** Cape Boileau, 35 km N of Broome, May 1991, *Thomson 3484* (DNA); 436.3 km NE of Port Hedland towards Broome, Sep 1995, *Lally TRL711* (BRI); 258 km SW of La Grange Mission turnoff, Great Northern Highway, Aug 1974, *Beauglehole ACB48293 & Carr* (PERTH); Nalgi Station, Jul 1941, *Burbidge 1341* (PERTH); Anna Plains, Jul 1941, *Burbidge 1477* (PERTH); Great Sandy Desert, May 1984, *Fatchen 849* (AD); 44 km (by road) along North West Coastal Highway from Roebourne towards Whim Creek, Sep 2006, *Halford Q9150* (BRI); Chichester Range, *c.* 13 km N of Roebourne – Wittenoom Road, N of Mt Florence, Sep 2006, *Halford Q9269* (BRI); 49.4 km N (by road) of Auski Roadhouse along Great Northern Highway, Sep

2006, *Halford Q9181a* (BRI); SW corner of Cane River Station, 80 km SE of Onslow, May 1999, *Edinger 1455* (PERTH); 2 km NE of North West Coastal Highway, in southern section of Cane River Station, May 1999, *Edinger 1665* (PERTH); 0.7 km SSW of Packsaddle Hill, Hamersley Ranges, Sep 1997, *Trudgen 16607* (PERTH); 31.3 km S of Nullagine on Nullagine – Newman Road, Aug 2004, *Harris WKH2235* (BRI); Patience Well, Gibson Desert, Jun 2001, *Campbell 2489* (PERTH); Bungle Bungle N.P., Ord River at Blue Holes, Jul 1989, *Menkhorst 695* (DNA). **Northern Territory.** 28.9 km E of Victoria River Crossing, Gregory N.P., Jun 2000, *Kerrigan 213 & Risler* (DNA); 5 miles [*c.* 8 km] SSE [of] Mongrel Downs homestead, Aug 1970, *Latz 750* (AD, DNA); 45 miles [*c.* 72 km] SW [of] Mongrel Downs homestead, Aug 1970, *Parker 283* (DNA, MEL, NSW); 46 miles [*c.* 74 km] E [of] Mongrel Downs homestead, Apr 1971, *Dunlop 2108* (DNA); Lake Mackay, Oct 1992, *Latz 12845* (MEL).

Distribution and habitat: *Euphorbia vaccaria* var. *vaccaria* is found from near Onslow, WA east to Victoria River Crossing and the Tanami Desert, NT (**Map 54a**). It grows in hummock grassland, *Eucalyptus*/*Acacia* shrubland/woodland communities on sandy loam to sandy clay soils on alluvial flats, or stony plains or hills. It has also been recorded growing on the margins of saltpans.

Phenology: Flowers and fruits have been collected mostly from April to September.

54b. Euphorbia vaccaria var. **erucoides** Halford & W.K.Harris, **varietas nova** ab *E. vaccaria* var. *vaccaria* foliis subtendentibus distaliter dentatis (ad vicem foliis integris vel minute dentatis) 1–1.8 mm longi (ad vicem pilis 0.8–1 mm longis), glandulae appendicibus plerumque longioribus 0.3–0.5 mm longis (ad vicem appendicibus 0.1–0.4 mm longis) differt. **Typus:** Western Australia. Fortescue River floodplain, *c.* 15 km N of Auski Roadhouse, old Great Northern Highway, 15 September 2006, *D.Halford Q9188* (holo: BRI; iso: MEL, PERTH).

Stems prostrate, with a sparse to moderately dense indumentum; hairs 1–1.8 mm long. **Leaf blades** obovate or oblong-elliptic, 4–9 mm long, 1.5–4 mm wide, 1.2–2.5 times longer than wide; adaxial and abaxial surfaces with sparse or moderately dense indumentum of hairs 0.5–1 mm long; base asymmetric with one side cordate to obtuse, the other cuneate to obtuse; margin toothed distally; apex rounded. **Involucral gland appendages** 0.3–0.5 mm long, 0.6–1 mm wide, red, margin shallowly irregularly lobed. **Pistillate flowers** with styles 0.4–0.5 mm long. **Capsules** exserted from involucre on pedicel to 3 mm long, 1.4–1.5 mm long, 1.6–1.9 mm across, hairs 1–1.5 mm long.

Additional selected specimens examined**: Western Australia.** Gregory Gorge, *c.* 20 km downstream from Millstream, May 1976, *Keighery 779* (PERTH); Millstream, Sep 1969, *Brooker 2057* (PERTH); Oakover River, 19 km S of Two Sisters, *c.* 160 km SE of Shay Gap, July 1984, *Newbey 10424* (PERTH); near northern shore of Guli Lake, Canning Stock Route, Aug 1989, *Barker 191* (PERTH); Cave Creek, 15 km NW of Mt Brockman Station (abandoned) on homestead block, Jul 1999, *Backhouse BEM14 et al.* (PERTH); Caves Creek, Hamersley Station, *c.* 75 km along Mt Brockman road W of Hamersley Station homestead, Sep 2006, *Halford Q9521* (BRI); Caves Creek, Mt Brockman road 50 km W of Hamersley Station homestead, Sep 2006, *Halford Q9256* (BRI); Hamersley Range N.P., 0.3 km from Mindi Spring on track to Coppin Pools, May 1980, *Trudgen 2615* (PERTH); Turee Creek, 1.5 km W of Mindi Springs, Hamersley Range N.P., Jun 1975, *Trudgen 1351* (PERTH); Hamersley Range N.P., 2.3 km from Mindi Springs on track to Milli Milli Springs, May 1980, *Trudgen 2385* (PERTH); 25 km E of Karijini Drive along service road of Hamersley Iron railway, Sep 2006, *Halford Q9208* (BRI); Roy Hill to Munjina Road, 7.2 km W of intersection with Nullagine – Newman Road, Sep 2004, *Harris WKH2238* (BRI); Turee Creek, Turee Station, *c.* 40 km E of Paraburdoo, Sep 2006, *Halford Q9233B* (BRI); 14.5 km W of Rhodes Ridge on Weeli Wolli Creek Road, Aug 1973, *Trudgen 420* (PERTH); Mundiwindi, Great Northern Highway, Jun 1970, *Briggs 3603* (NSW, PERTH); Little Sandy Desert, 26.6 km ESE of Burranbar Pool on Savory Creek, 37.9 km NE of Cooma Well, 61.8 km N of Terminal Lake, 38.9 km NNW of the Dean Hills, Apr 1997, *van Leeuwen 3043* (BRI).

Distribution and habitat: *Euphorbia vaccaria* var. *erucoides* occurs in the Chichester and Hamersley Ranges, and extending eastward to Guli Lake, in the Great Sandy Desert (**Map 54b**). It grows in *Eucalyptus*/*Melaleuca* riparian forest or woodland communities on sandy loam to loam or gravelly alluvium in dry river beds, on creek and river banks or alluvial flats, and in hummock grassland, mallee or mulga woodland communities on sandy loam to sandy clay soils often with calcrete on plains.

Phenology: Flowers and fruits have been collected from mostly from May to September.

Notes: *Euphorbia vaccaria* var. *erucoides* differs from *E. vaccaria* var. *vaccaria* in having subtending leaves distinctly toothed distally (versus entire or minutely toothed for *E. vaccaria* var. *vaccaria*), indumentum 1–1.8 mm long (versus 0.8–1 mm long for *E. vaccaria* var. *vaccaria*) and generally longer gland appendages, 0.3–0.5 mm long (versus 0.1–0.4 mm long for *E. vaccaria* var. *vaccaria*).

Etymology: The varietal epithet is Latin *eruca*, caterpillar, and *-oides*, like, resembling, in reference to the colloquial name 'caterpillar plant' used by ecological investigators in the Pilbara region for this taxon. The cyathia are clustered on short leafy lateral branchlets, the clusters somewhat resemble a hairy caterpillar.

55. Euphorbia verrucitesta Halford & W.K.Harris, **species nova** ut videtur arcte affinis *E. philochalicis* Halford & W.K.Harris sed glandulae appendicibus brevioribus c. 0.5 mm longis (ad vicem appendicibus 0.1–0.3 mm longis), seminibus plerumque longioribus 1.1–1.2(1.3) mm longis (ad vicem seminibus 0.9–1.1 mm longis), seminum superficiebus verrucis irregularibus ornatis (ad vicem superficiebus porcis prominentibus irregularibus ornatis) differt. *Euphorbia verrucitesta* habitu generali, glandibus involucralibus, glandulae appendicibus *E. multifariae* Halford & W.K.Harris persimilis sed differt autem capsulis minoribus 1.3–1.5 × 1.5–1.7 mm perlato-ovatis in ambitu (ad vicem capsulis 1.5–1.9 × 1.5–2.1 mm lato-ellipticis in ambitu), seminum superficiebus verrucis irregularibus ornatis (ad vicem superficiebus laevibus vel leviter irregulariter porcatis). Ante hac eandem cum *E. drummondii* Boiss. putata est sed seminum superficiebus verrucis parvis irregularibus (ad vicem superficiebus 3–6 porcis transversis), capsulis minoribus 1.3–1.5 × 1.5–1.7 mm (ad vicem capsulis 1.6–1.8 × 1.7–1.9 mm), seminibus lato-obovatis in ambitu (ad vicem seminibus oblongo-ovatis in ambitu), stylis bifidis 1/3–1/2 longitudinis (ad vicem stylis integris vel vix bifidis) differt. **Typus:** South Australia. 85 km S of Oldea, 25 September 1960, *P.Wilson 1845* (holo: AD).

Monoecious, annual to 5 cm high, many stems arising from slender taproot, the whole plant glabrous. **Stems** prostrate, much branched, smooth. **Interpetiolar stipules** subulate or narrow-triangular, 0.4–1 mm long, bipartite, glabrous; margin laciniate. **Leaves**: petiole 0.3–0.7 mm long, smooth; blade obovate, oblong or oblong-elliptic, 3.5–7 mm long, 2–4.5 mm wide, 1.4–2.1 times longer than wide; adaxial and abaxial surfaces green sometimes with reddish tinge especially along margins, smooth or minutely papillose; base symmetric, rounded to cuneate or asymmetrical with one side cordate or rounded, the other cuneate, obtuse or rounded; margin entire or sparingly minutely toothed distally; apex retuse or rounded. **Cyathia** solitary at the nodes, peduncles 0.3–0.6 mm long. **Involucres** turbinate, 0.8–1.1 mm long, 0.9–1 mm across; lobes 5, triangular, 0.3–0.5 mm long, margin entire, fimbriate or laciniate; glands 4, stipitate, cupuliform, with shallow central pit and somewhat thickened rim, transverse-oblong in outline, 0.1–0.2 mm long, 0.2–0.4 mm wide, red; gland appendages inconspicuous or absent, spreading radially, transverse-linear, obdeltoid or oblong, *c.* 0.05 mm long, 0.1–0.2 mm wide, pink, glabrous, margin entire; bracteoles 0.5–0.7 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into few subulate glabrous or hirsute segments. **Staminate flowers** 4 or 5 (10) per cyathium; pedicels 0.9–1.1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.2–0.4 mm long, spreading, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices stout and terete. **Capsules** exserted from involucre on pedicel to 2 mm long, very broad-ovate in lateral view, 1.4–1.5 mm long, 1.5–1.7 mm across, shallowly 3-lobate with keels obtuse, smooth, glabrous; hypogynous disc entire. **Seeds** broad-ovate in outline, 1–1.2(1.3) mm long, 0.7–0.8 mm tangentially, 0.6–0.7 mm radially, tetraquetrous in cross section; dorsal and ventral faces planar or shallowly concave, with prominent rounded irregular wart-like protuberances; exotesta thin, of even thickness over surface, white or pale brown, microreticulate, becoming mucilaginous when moistened; endotesta red-brown. **Figs 22, 28I.**

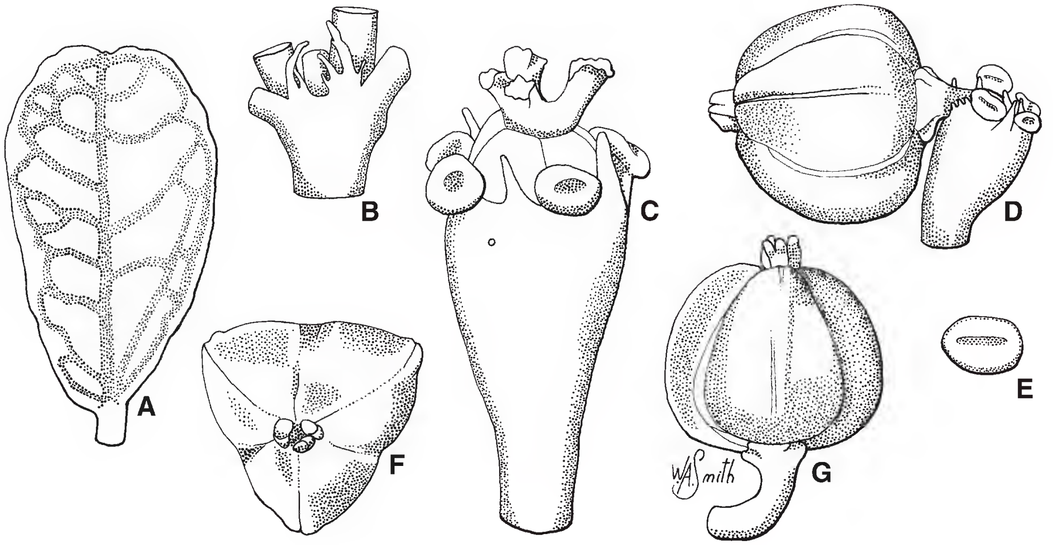

Fig. 22. ***Euphorbia verrucitesta.*** A. leaf ×12. B. stipules ×16. C. cyathia with female flower ×32. D. cyathia with fruit ×16. E. cyathial gland with appendage, adaxial view ×32. G. capsule, lateral view ×16. F. capsule, top view ×16. All from *Wilson 1845* (AD). Del. W.Smith.

***Additional selected specimens examined*:** **Western Australia.** 16 km E of Cocklebiddy, Oct 1984, *Keighery 7543* (PERTH); 104 km S of Neale Junction, Great Victoria Desert, Jul 1974, *George 11932* (PERTH); 52 km W of Naretha, Jun 1966, *Goodall 2762* (PERTH). **South Australia.** S of Uno Range near Lake Gilles, Jul 1992, *Bates 28625* (AD); Koonamore, near 'Bindyi' Research Hut, Aug 1966, *Orchard 55* (AD); near Shell Hill, Dec 1983, *Spooner 9115* (AD); R.Lencer Reserve, Punthari, Mar 1997, *Spooner 16298* (AD). **New South Wales.** 2 km W along N boundary track from main road, them *c.* 100 m S in Bluff Paddock, Nulla Nulla Station, Nov 2000, *Jobson 6586 et al.* (NSW).

***Distribution and habitat*:** *Euphorbia verrucitesta* occurs from near Southern Cross and Esperance, WA, eastward across the Nullarbor through southern SA to far south western NSW (**Map 55**). It has been recorded growing in *Acacia papyrocarpa* Benth. woodland and chenopod shrubland on limestone plains and in *Austrostipa* open grassland on sand plain and interdune swales. It is also recorded on rocky mesas and granite hills. The soils are sands or loams often associated with limestone or gypsum.

***Phenology*:** Flowers and fruits have been collected throughout the year, but mostly in October.

***Notes*:** *Euphorbia verrucitesta* seems most closely related to *E. philochalix*. It may be distinguished from that species by its shorter gland appendages (*c.* 0.5 mm long versus 0.1–0.3 mm long for *E. philochalix*), generally longer seeds (1.1–1.2(1.3) mm long versus 0.9–1.1 mm long for *E. philochalix*) and irregular wart-like protuberances on the seed surface (versus prominent irregular rounded ridges for *E. philochalix*).

Euphorbia verrucitesta is very similar to *E. multifaria* in general habit, involucral glands and gland appendages. It differs from *E. verrucitesta* by its smaller capsules 1.3–1.5 × 1.5–1.7 mm that are very broad-ovate in outline (versus 1.5–1.9 × 1.5–2.1 mm, broad-elliptic in outline for *E. multifaria*) and irregular wart-like protuberances on the seed surface (versus smooth or faintly irregularly ridged seed surface for *E. multifaria*).

Euphorbia verrucitesta has previously been identified as *E. drummondii*, but differs from that species in having small irregular wart-like protuberances on the seed surface (versus seed surfaces with 3–6 distinct transverse ridges for *E. drummondii*), smaller capsules (1.3–1.5 × 1.5–1.7 mm versus 1.6–1.8 × 1.7–1.9 mm for *E. drummondii*), seeds broad-obovate in outline (versus oblong-obovate for *E. drummondii*) and styles that are bifid for 1/3–1/2 of their length (versus styles entire or scarcely bifid for *E. drummondii*).

***Etymology*:** The specific epithet is from Latin *verrucus*, warts, and *testa*, seed coat, in reference to the warty appearance of the seed surface of this species.

56. Euphorbia vicina Halford & W.K.Harris, **species nova** ante hac eandem falso cum *E. mitchelliana* Boiss. vel *E. schultzii* Benth. putata est. Cum generaliter similem *E. mitchellianae* tamen cyathiis in cymis dichasialibus congestis (in vicem cymis laxis terminalis dichasialibus vel aliquando monochasialibus distaliter nascentibus) differt. Ab *E. schultzii* in cymis congestis dispositis (ad vicem solitariis vel in ramulis abbreviatis lateralibus fasciculatis), capsulis 1.4–1.6 × 1.9–2 mm lato-ellipticis a latere visis leviter 3-lobatis carinis obtusis praeditis (ad vicem capsulis 1.5–2.2 × 2–3 mm depresse ovatis vel transverse ellipticis usque lato-ellipticis a latere visis valde 3-lobatis carinis acutis praeditis), seminibus tetragonis in sectione transversali (ad vicem seminibus tetraquetris) differt. **Typus:** Western Australia. 5 km N [of] Theda homestead, 2 April 1991, *B.G.Thomson 3467* (holo: PERTH; iso: NT).

Monoecious, annual to 30 cm high, with few stems arising from slender taproot. **Stems** ascending to erect, sparingly to much branched, smooth, with a sparse to moderately dense indumentum; hairs ascending, curved, 0.2–0.7 mm long, white. **Interpetiolar stipules** narrow-triangular, 0.6–1 mm long, deeply bipartite, glabrous or with indumentum as for stems; margin laciniate with the teeth often gland-tipped. **Leaves**: petiole 1–1.5 mm long, smooth, glabrous or with indumentum as for stems; blade narrow-ovate to ovate, 12–21 mm long, 2–9 mm wide, 2–5.5 times longer than wide; adaxial and abaxial surfaces green, smooth or minutely papillose, with a sparse to moderately dense indumentum consisting of ascending, curved hairs 0.4–1.2 mm long (rarely glabrous); base asymmetric with one side cordate, the other rounded to obtuse; margin serrulate (rarely entire); apex acute. **Cyathia** clustered in congested dichasial cymes on short axillary branchlets with bracts leaf-like but much smaller than primary stem leaves; cyathial peduncles *c.* 0.5(2) mm long. **Involucres** turbinate to cupuliform, 0.7–1 mm long, 0.8–1.3 mm across; lobes 5, triangular, 0.5–0.6 mm long, margin entire or laciniate; glands 4, stipitate, cupuliform, with shallow central pit, transverse-oblong to orbicular in outline, 0.2–0.3 mm long, 0.2–0.3 mm wide, red; gland appendages inconspicuous or absent, spreading radially, obdeltoid, *c.* 0.1 mm long and 0.1 mm wide, pink, glabrous, margin entire; bracteoles 0.4–0.6 mm long, adnate for *c.* 1/4 of their length to involucre, free portion divided into ± linear hairy segments. **Staminate flowers** 5–10 per cyathium; pedicels 0.6–0.8 mm long; staminal filaments 0.1–0.2 mm long. **Pistillate flowers**: styles 0.3–0.4 (0.9) mm long, connate at the base into a column for up to 1/5 of their length, spreading, ± smooth, glabrous, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2 mm long, broad-elliptic in lateral view, 1.4–1.6 mm long, 1.9–2 mm across, shallowly 3-lobate with keels obtuse, papillose, with a sparse indumentum consisting of spreading white hairs 0.1–0.3 mm long (rarely glabrous); hypogynous disc entire. **Seeds** broad-ovate in outline, 1.1–1.3 mm long, 0.7–0.8 mm tangentially, 0.7–0.8 mm radially, tetragonous in cross section; dorsal faces ± convex; ventral faces concave or planar; all faces with faint regularly ridges or with 3 or 4 faint or prominent, acute narrow transverse ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta brown. **Figs 23, 28J.**

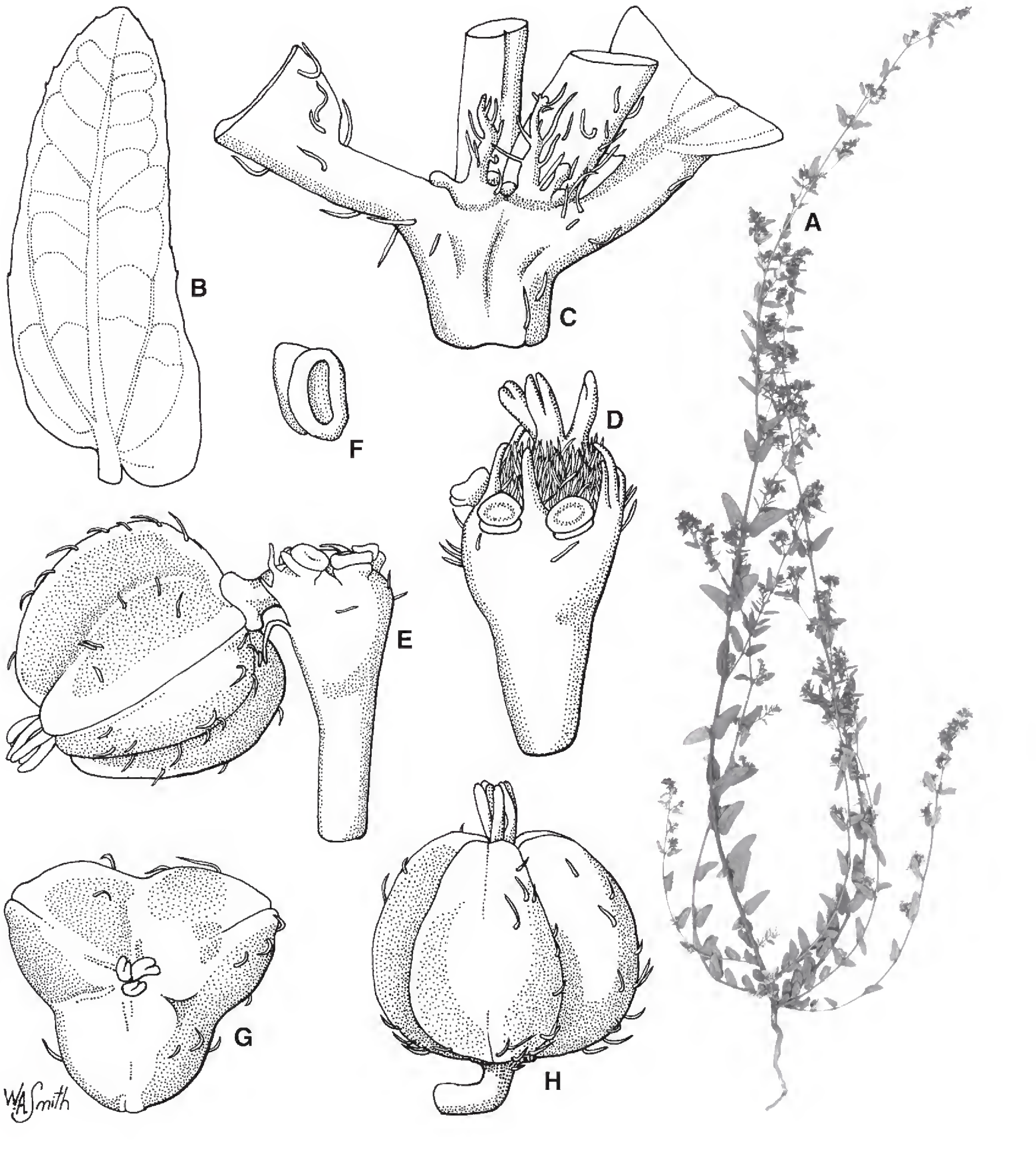

Fig. 23. ***Euphorbia vicina***. A. habit ×0.4. B. leaf ×4. C. stipules ×24. D. cyathia with female flower ×24. E. cyathia with capsule ×16. F. cyathial gland with appendage, adaxial view ×32. G. capsule, top view ×16. H. capsule, lateral view ×16. A from *Keighery 4928* (PERTH); B–H from *Fraser s.n.* (PERTH 3079074). Del. W.Smith.

***Additional specimens examined*: Western Australia.** Mitchell Plateau, Apr 1982, *Keighery 4928* (PERTH); 'Black Mud Swamp', 24 km from Amax Campsite on road to Mitchell River Station, Jun 1976, *Kenneally 5303/A* (PERTH); summit of Poompangala Hill, *c.* 8 km W of Kalumburu, Apr 1991, *Willing 249* (PERTH); 2 km E of junction of Charnley and Calder River, Eastern Walcott Inlet, May 1983, *Milewski 207* (PERTH); Mt Hart Station, Feb 1951, *Fraser s.n.* (PERTH 3079066, 3079074).

***Distribution and habitat*:** *Euphorbia vicina* is restricted to the Kimberley, WA, occurring from the Mitchell Plateau and Kalumburu areas south to Mt Hart Station (**Map 56**). It grows in moist areas in herbland, grassland or woodland communities on shallow sandy soils, on lateritic mesas or sandstone plateaux.

***Phenology*:** Flowers and fruits have been collected from February to June.

***Notes*:** *Euphorbia vicina* has been in the past erroneously referred to *E. mitchelliana* or *E. schultzii*. Although *E. vicina* does bear a general resemblance to *E. mitchelliana* it differs from that in having cyathia in congested dichasial cymes (versus lax terminal dichasial or sometimes becoming monochasial distally for *E. mitchelliana*) and capsules with a papillose surface (versus smooth for *E. mitchelliana*).

Euphorbia vicina differs from *E. schultzii* in having cyathia in congested cymes (versus solitary or clustered on shortened leafy lateral branchlets for *E. schultzii*), capsules 1.4–1.6 × 1.9–2 mm, broad-elliptic in lateral view and shallowly 3-lobate with keels obtuse (versus 1.5–2.2 × 2–3 mm, depressed ovate or transverse-elliptic to broad-elliptic in lateral view and deeply 3-lobate with keels acute for *E. schultzii*) and seeds tetragonous in cross section (versus tetraquetrous in cross section for *E. schultzii*).

We have seen very few ample collections of this species and consequently the morphological variation within this species is poorly understood. The specimen *Milewski 207* is tentatively placed here. However, it has somewhat larger capsules and more prominent transversely ridged seeds than what are considered typical for this species.

***Etymology*:** The specific epithet is from Latin *vicinus*, near, neighbouring, in reference to the species' morphological similarity to *E. mitchelliana*.

57. Euphorbia victoriensis Halford & W.K.Harris, **species nova** arcte similis morphologice *E. wheeleri* Baill. in simili sede crescens sed in tractu geographice disjuncto. Habitu plerumque minori seminum superficiebus porcis 4–6 prominentibus angustis rotundatis (ad vicem superficiebus foveatis vel reticulo-foveatis), capsulis minoribus 1.8–1.9 mm longis (ad vicem capsulis 2–2.8 mm longis) differt. Ante hac eandem cum *E. drummondii* Boiss. putata est sed seminum superficiebus porcis 4–6 prominentibus angustis rotundatis (ad vicem porcis 3–6 transversis distinctis), stipulis brevioribus 0.3–0.4 mm longis (ad vicem stipulis 0.5–0.9 mm longis), glandis involucralibus patelliformibus superficiebus planis concavisve (ad vicem glandulis cupuliformibus lacuna centrali distincta et ore incrassata praeditis) stylis 0.4–0.6 mm longis 1/3–1/2 longitudinis bifidis apicibus teretibus ornatis (ad vicem stylis 0.2–0.3 mm longis integris vel vix bifidis apicibus clavatis ornatis) differt. **Typus:** Western Australia. *c.* 43 km W of Serpentine Lakes, 18 July 1972, *N.N.Donner 3943* (holo: AD).

Monoecious, annual or herbaceous perennial with slender woody taproot, few to many stems arising from rootstock, the whole plant glabrous. **Stems** prostrate or rarely erect, sparingly to much branched, smooth. **Interpetiolar stipules** narrow-triangular, 0.3–0.4 mm long, deeply bipartite; margin laciniate. **Leaves**: petiole 0.6–1 mm long, smooth; blade oblong or oblong-obovate, 3.6–7.2(11.5) mm long, 2.5–3.1(6.4) mm wide, 1.4–2.4 times longer than wide; adaxial and abaxial surfaces green sometimes with reddish tinge; smooth; base asymmetric with one side cordate or obtuse, the other cuneate; margin serrulate, sometimes only distally (rarely entire); apex rounded. **Cyathia** solitary at the distal nodes; peduncles *c.* 0.5 mm long, smooth. **Involucres** turbinate, 0.7–0.9 mm long, 0.9–1.1 mm across; lobes 5, triangular, 0.3–0.4 mm long, margin fimbriate; glands

4, stipitate, patelliform, planar to shallowly concave, transverse-oblong or reniform in outline, 0.2–0.3 mm long, 0.4–0.7 mm wide, yellowish green sometimes with reddish tinge; gland appendages inconspicuous or absent, spreading radially, transverse-linear, to 0.1 mm long, 0.6–0.7 mm wide, white often with reddish tinge, glabrous, margin erose; bracteoles 0.8–1 mm long, adnate for *c.* 1/4 of their length to involucre, free portion divided into ± linear hairy segments. **Staminate flowers** 8–15 per cyathium; pedicels 0.8–1 mm long; staminal filaments *c.* 0.1 mm long. **Pistillate flowers**: styles 0.4–0.6 mm long, spreading, recurved distally, smooth, glabrous, each bifid for 1/3–1/2 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 2 mm long, broad-elliptic in lateral view, 1.8–1.9 mm long, 1.9–2.1 mm across, shallowly 3-lobate with keels obtuse, smooth; hypogynous disc entire. **Seeds** ovate in outline, 1.5–1.7 mm long, 0.9–1 mm tangentially, 0.9–1 mm radially, tetraquetrous in cross section; dorsal faces convex; ventral faces planar; all faces with 4–6 prominent, narrow, rounded, irregular ridges; exotesta thin, of even thickness over surface, grey-white, microreticulate, becoming mucilaginous when moistened; endotesta red-brown or dark brown. **Figs 24, 28K.**

Additional selected specimens examined: **Western Australia.** 11 miles [*c.* 18 km] E of Notabilis Hill, Gunbarrel Highway, Gibson Desert, Jul 1963, *George 5364* (PERTH); 33 miles [*c.* 53 km] SE of Windulda (Warburton Road), Aug 1962, *George 4009* (PERTH). **Northern Territory.** near Mt Connor, Jul 1958, *Cleland s.n.* (AD 966060055). **South Australia.** near WA border and Serpentine Lakes on road W of Emu, Jul 1979, *Williams 10671* (AD); 155 km W of Vokes Hill Junction, Aug 1980, *Alcock 8272* (AD); Anne Beadell Highway, unnamed Conservation Park, Great Victoria Desert, Aug 2001, *Friebe S112* (AD); 35 km W of Vokes Hill road junction, Jul 1979, *Williams 10535* (AD); *c.* 52 km W of Vokes Hill, corner on Connie Sue Highway, Aug 1980, *Mowling s.n.* (AD 98597043); 132 km N of Cook, Aug 1980, *Alcock 7980* (AD); 52 km N [of] Muckera Rockhole, Oct 1987, *Canty 2383* (AD); 98 km N of Cook on the road to Vokes Corner, Aug 1980, *Donner 7513* (AD).

Distribution and habitat: *Euphorbia victoriensis* occurs in the Great Victoria Desert in WA and SA. It has also been recorded from the southern corner of the Gibson Desert, WA and the south western corner of the NT (**Map 57**). It has been recorded growing in open woodland communities on sand dunes.

Phenology: Flowers and fruits have been collected from July to October.

Notes: *Euphorbia victoriensis* is morphologically most similar to *E. wheeleri* and grows in a similar habitat although occurring in separate geographical areas. *Euphorbia victoriensis* differs in having a generally smaller habit, seeds surfaces with 4–6 prominent, narrow, rounded, irregular ridges (versus seed surfaces foveate or reticulate-foveate for *E. wheeleri*) and smaller capsules (1.8–1.9 mm long versus 2–2.8 mm long for *E. wheeleri*).

Euphorbia victoriensis has been previously identified as *E. drummondii*. It differs from that species in having seed surfaces with 4–6 prominent, narrow, rounded, irregular ridges (versus 3–6 distinct transverse ridges for *E. drummondii*), shorter stipules (0.3–0.4 mm long versus 0.5–0.9 for *E. drummondii*), involucral glands patelliform with a planar or concave surface (versus glands cupuliform, with distinct central pit and thickened rim for *E. drummondii*) and styles 0.4–0.6 mm long and bifid for 1/3–1/2 of their length, with terete apices (versus styles 0.2–0.3 mm long, entire or scarcely bifid, with clavate apices for *E. drummondii*).

Etymology: The species epithet refers to the Great Victoria Desert, in WA and SA, where this species occurs.

58. Euphorbia wheeleri Baill., *Adansonia* 6: 286–287 (1866); *Chamaesyce wheeleri* (Baill.) D.C.Hassall, *Aust. J. Bot.* 24: 640 (1976). **Type:** [Queensland. GREGORY SOUTH DISTRICT:] between Stokes Range and Coopers Creek, *s.d.*, *Dr Wheeler s.n.* (holo: P 313105; iso: MEL 1520270).

Illustration: Weber (1986: 755, fig. 403C).

Monoecious (rarely dioecious), herbaceous perennial to 50 cm high, with many stems arising from crown of thickened woody taproot, the whole plant glabrous. **Stems** ascending to erect or occasionally prostrate to decumbent, smooth. **Interpetiolar stipules**

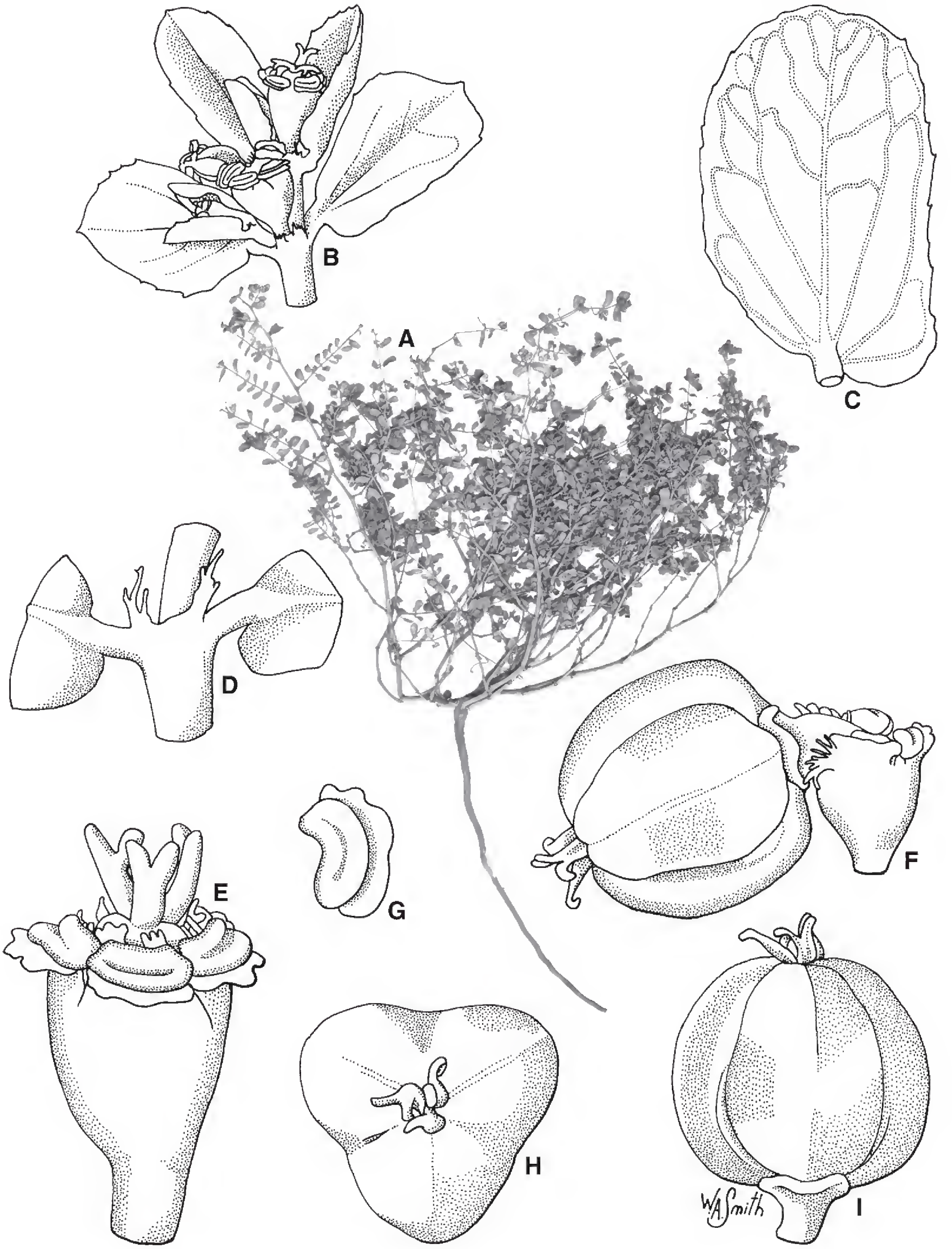

Fig. 24. ***Euphorbia victoriensis***. A. habit ×0.6. B. branchlet with cyathia ×8. C. leaf ×8. D. stipules ×16. E. cyathia with female flower ×32. F. cyathia with fruit ×16. G. cyathial gland with appendage, adaxial view ×32. H. capsule, top view ×16. I. capsule, lateral view ×16. A from *Canty 2383* (AD); B–I from *Donner 3943* (AD). Del. W.Smith.

triangular or subulate, 0.6–1.6 mm long, deeply bipartite; margin laciniate. **Leaves**: petiole 0.3–1.4 mm long, smooth; blade oblong-elliptic, elliptic, oblong or sometimes obovate, 4–18 mm long, 2–8 mm wide, 1.7–2.4 times longer than wide; adaxial surface bright or dark green, smooth; abaxial surface pale green, smooth; base asymmetric with one side cordate, the other side cuneate; margin serrulate sometimes only distally or entire; apex rounded or retuse. **Cyathia** solitary at the nodes; peduncles 0.5–2 mm long, smooth. **Involucres** turbinate or cupuliform, 1–1.4 mm long, 0.9–1.9 mm across; lobes 5, triangular, 0.4–0.5 mm long, margin fimbriate; glands 4, stipitate, patelliform, planar or shallowly concave, transverse-oblong to ± reniform in outline, 0.2–0.4 mm long, 0.4–0.8 mm wide, yellow, pink or red; gland appendages conspicuous to inconspicuous, spreading radially, lunate, 0.1–0.4 mm long, 0.8–1 mm wide, pink or white, glabrous, margin entire or shallowly irregularly lobed; bracteoles 0.8–1 mm long, adnate for *c.* 1/3 of their length to involucre, free portion divided into ± linear hairy segments. **Staminate flowers** 20–25 per cyathium; pedicels 1–1.2 mm long; staminal filaments 0.3–0.4 mm long. **Pistillate flowers**: styles 0.4–0.8 mm long, ascending to erect, spreading distally, smooth, each bifid for 1/2–2/3 of their length, the apices terete. **Capsules** exserted from involucre on pedicel to 3 mm long, elliptic to broad-elliptic in lateral view, 2–2.8 mm long, 1.9–2.4 mm across, shallowly 3-lobate with keels obtuse, smooth; hypogynous disc entire. **Seeds** ovate in outline, 1.5–2.2 mm long, 0.8–1.2 mm tangentially, 0.7–1.1 mm radially, tetragonous in cross section; dorsal faces convex; ventral faces ± planar; all faces foveate or reticulate-foveate; exotesta thin, of even thickness over surface, white, microreticulate, becoming mucilaginous when moistened; endotesta pale brown. $n = 11$. **Figs 28L, M.**

Additional selected specimens examined: **Western Australia.** *c.* 10 km SW of rockhole, Wilson Cliffs, Great Sandy Desert, May 1977, *deGraaf 36* (PERTH); 60 miles [*c.* 96 km] NW of Giles, Aug 1962, *Kuchel 280* (AD). **Northern Territory.** Lake Surprise area, Mar 1973, *Henry 621* (DNA); False Mt Russell, 78 miles [*c.* 125 km] WSW [of] The Granites, Aug 1970, *Latz 716* (AD, MEL); Finke River Railway Xing [crossing], Nov 1993, *Albrecht 5531* (DNA, NT); Maryvale Station, junction of Blackhill Bore and Maryvale Road, Aug 1988, *Barritt 746* (DNA); 1.5 km SSW [of] Indracowra homestead, Aug 2000, *Albrecht 9376* (NT); Amerada Petroleum Corp. No. 1 Hale River, Nov 1966, *Symon 4376* (AD). **Queensland.** GREGORY NORTH DISTRICT: Monkira Station towards Cluny Station, Sep 1969, *Gittins 1952* (BRI, NSW); 164 km from Windorah on Bedourie Road, Apr 1997, *Forster PIF20607 & Holland* (BRI, MEL). GREGROY SOUTH DISTRICT: 10 miles [*c.* 16 km] E of Birdsville, May 1975, *Hassall 7523* (BRI); 40 miles [*c.* 64 km] W of Windorah, May 1975, *Hassall 7527* (BRI); Mt Howitt Station, 128 km W of Eromanga, Jul 1936, *Blake 11921* (AD, BRI); 83 km by road NW of Quilpie on the road to Windorah, Mar 2001, *Thomas 1936 & Fechner* (BRI). **South Australia.** Simpson Desert, Aug 1991, *Jessop 124* (AD, BRI); Birdsville Track, Goyder Lagoon, Aug 1975, *Jackson 2733* (AD); Oodnadatta, Dec 1977, *Knight 212* (AD); Mungeranie homestead, Sep 1956, *Cleland s.n.* (AD 96806425); 5 km SSW of Olympic Dam Mine, May 1989, *Badman 2588* (AD). **New South Wales.** 2.7 km ESE of Cameron Corner, Oct 1986, *Rodd 5773 et al.* (AD, NSW).

Distribution and habitat: *Euphorbia wheeleri* is widespread in central Australia from the Great Sandy and Gibson Deserts, in WA, through southern NT and northern-east SA to south-western Qld and far north-western NSW (**Map 58**). It grows primarily in open shrubland or *Zygochloa* grassland communities on deep red sands or sandy loams on desert dunes, also recorded on interdune flats, sandy river banks, and in *Triodia* grassland on deep red sand on open sandplains.

Phenology: Flowers and fruits have been collected throughout the year, particularly from May to October.

Notes: *Euphorbia wheeleri* is morphologically most similar to *E. myrtoides* and *E. victoriensis.* In addition to its geographic separation for those species, it is easily distinguished from both species by its foveate to reticulate-foveate seed surface.

As accepted here, *Euphorbia wheeleri* shows some variation in the seed shape and seed surface texture. The typical form occurs across the species range, and has seeds that are generally slender (1.6–2.2 × 0.8–1 × 0.7–0.9 mm) with a foveate surface (**Fig. 26M**). A second less common form is found only in the region from near Finke, NT, south to Arcoona, SA. The seeds are generally shorter and broader (1.5–1.9 × 1.1–1.2 × 1–1.1 mm) and have a reticulate-foveate surface (**Fig. 26N**). Representative specimens of this second form are: Northern Territory. Bundooma, Jun 1935, *Cleland s.n.* (AD 97405252); Uluru N.P., 34 km WNW of Ranger Station, May 1988, *Lazarides 153 & Palmer* (AD, DNA); Erldunda Station, Jun 1935, *Cleland s.n.* (AD 97405248). South Australia. near Marla, Apr 1997, *Bates 47351* (AD); Pedirka, Aug 1932, *Ising s.n.* (AD 966031152); *c.* 8 km E of Macumba homestead, Sep 1931, *Ising s.n.* (AD 966030967); Moonlands Bore, Todmorden Station, Aug 1992, *Badman 5869* (AD 99326003); Macumba Station, Nov 1950, *Ising s.n.* (AD 966150249); off Borefield road, near Canegrass Swamp, Apr 1997, *Bates 46879* (AD); Arcoona, Sep 1927, *Murray 170* (AD). This variant may, with further collections and research, be found to represent a distinct taxon.

Excluded names

Euphorbia atoto G.Forst., *Fl. Ins. Austr.* 36 (1786); *Chamaesyce atoto* (G.Forst.) Croizat, in O. Degener, *Fl. Hawaiiensis Fam.* 190. (1936). **Type:** Society Islands, Tahiti, *s.d.*, *Herbier Forster 110* (lecto: P-Forst *n.v.* [image seen]; isolecto: BM 1014903 *n.v.* [image seen], G *n.v.*, GEOT *n.v.* [image seen], UPS-THUNB *n.v.* (IDC microfiche 1036-16. 479, II. 1), *fide* Florence [1996: 242–243]).

As circumscribed by Florence (1996), *Euphorbia atoto* is endemic to Tahiti. The Australian specimens previously assigned to this species are referrable to *E. litticola*, *E. obliqua* or *E. pallens*.

Euphorbia chamaesyce L., *Sp. Pl.* 1: 455 (1753). **Type:** “Habitat in Europa australi, Sibiria” unknown locality, *s.d.*, *Löfling 373* (lecto: LINN [*Herb. Linn. No. 630.15*] *n.v.* (image seen) (IDC microfiche 177. 320: I. 1), *fide* Khan [1964: 152]).

In Australia, this name has been misapplied to *Euphorbia drummondii*, *E. maculata*, *E. prostrata* and *E. thymifolia* (Hooker 1855–1859; Dunlop *et al.* 1995; Paczkowska & Chapman 2000).

Euphorbia drummondii var. *dallachyana* Baill., *Adansonia* 6: 285 (30 July 1866). **Type citation:** “Dallachy, “Pine Plains”, cum typo (Herb. F. Muell.!) – Murray, Cooper’s creek (herb. F. Muell.!)”.

We have been unable to locate the type material of this variety. There is a collection in MEL (2179478) with the information “*Euphorbia drummondii*, Baill. Cooper’s Creek” hand written on a blue Phytologic Museum of Melbourne label. There is no indication that it was seen by Baillon or that it is *E. drummondii* var. *dallachyana* of Baillon. This collection is referrable to *E. dallachyana*.

Euphorbia drummondii var. *erythropeplis* Baill., *Adansonia* 6: 285 (30 July 1866). **Type:** Western Australia. Murchison R., [without date,] *Oldf.* [*Oldfield*] *1082* (holo: MEL 2179193).

There is insufficient material to place this name with any certainty. The seeds and fruits of this taxon are unknown. The involucral glands and gland appendages are similar to *Euphorbia drummondii*; however, the leaves are smaller and thicker, and more or less entire.

Euphorbia bracteolaris Boiss., *Cent. Euphorb.* 8 (1860). *Euphorbia hypericifolia* var. *bracteolaris* (Boiss.) Ewart, *Proc. Roy. Soc. Victoria* 19: 41 (1907). **Type citation:** “In montibus Nilagiricis Indiae (Perrottet sub n. 1832 ex parte).”

This name is not applicable to any Australian taxon. The Australian specimen (Elder Expl. Exp. 1892 lat 27 deg. 5 mS., long. 119 deg. 15 m. E [MEL 2179930]) assigned by Ewart (*loc. cit.*) to this variety is referable to *Euphorbia coghlanii*.

Euphorbia pilulifera L., *Sp. Pl.*: 454 (1753), *nom. rej.*, *fide* Esser & Cafferty (2001); (2006). McNeill *et al.* (2006). **Type:** “Habitat in India.” (lecto: LINN [*Herb. Linn. No. 630.8*] (image seen), *fide* Brown *et al.* (1911: 497–498)).

In Australia, the name *Euphorbia pilulifera* has been misapplied to the species *E. hirta* (Bentham 1873; Domin 1927). The correct name for the type of the name *E. piluliferia* is *E. parviflora* L. This name is not applicable to any Australian species.

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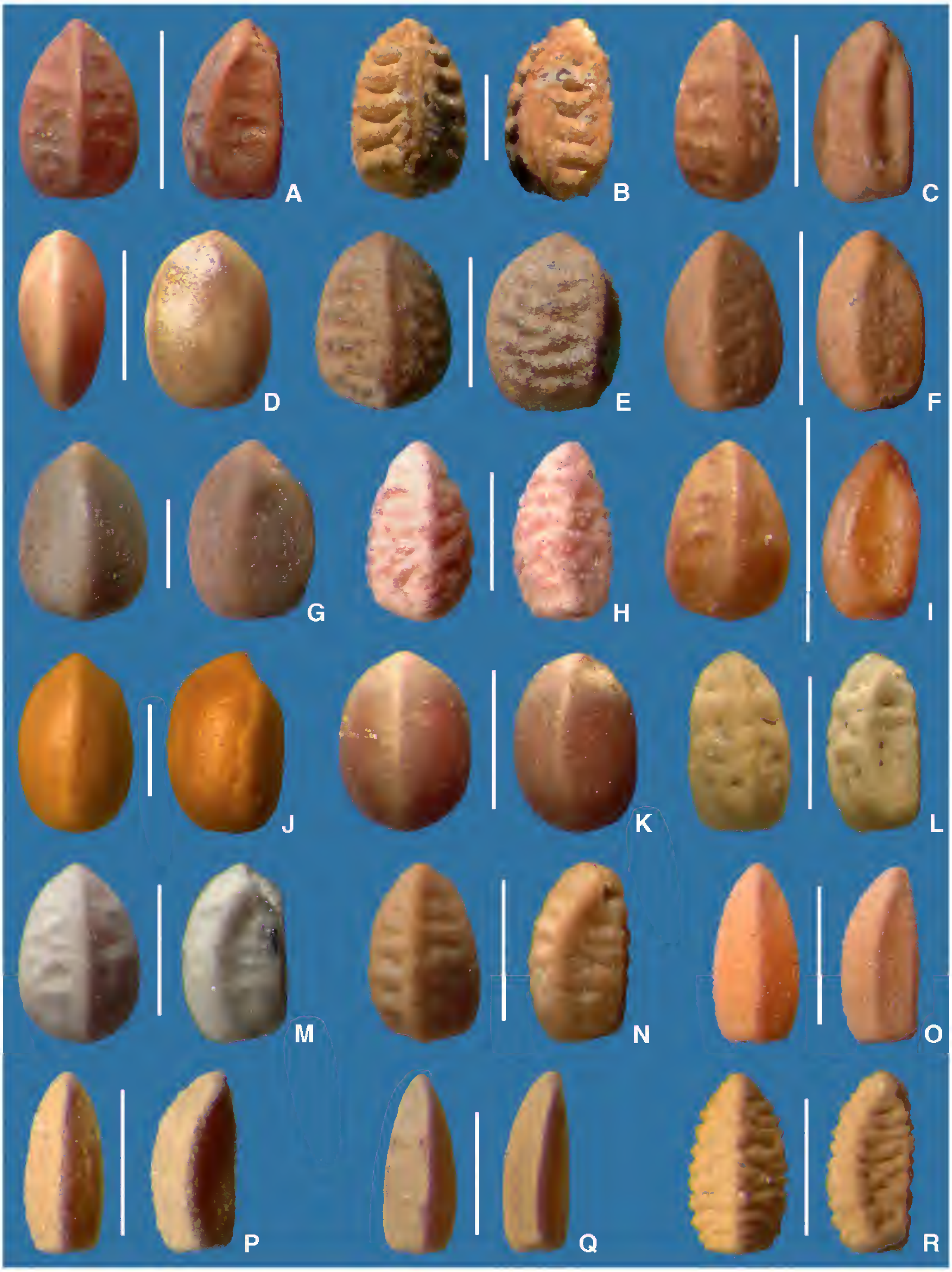
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Fig. 25.

← **Fig. 25.** Dorsal and lateral views of *Euphorbia* seeds: A. *E. albrechtii* [*Chippendale 2019* (DNA)]. B. *E. armstrongiana* var. *distans* [*Fryxell & Craven 3889* (PERTH)]. C. *E. australis* var. *subtomentosa* [*Trudgen 2616* (PERTH)]. D. *E. biconvexa* [*Halford Q9061 & Batianoff* (BRI)]. E. *E. bifida* [*Williams 7679* (BRI)]. F. *E. careyi* [*Mitchell PRP1492* (BRI)]. G. *E. carissoides* [*Forster PIF30791* (BRI)]. H. *E. centralis* [*Latz 908* (DNA)]. I. *E. cinerea* [*Cranfield 6728* (PERTH)]. J. *E. clementii* [*Thomson 3498* (BRI)]. K. *E. coghlanii* [*Halford Q9015 & Batianoff* (BRI)]. L. *E. crassimarginata* [*McDonald KRM4047* (BRI)]. M. *E. dallachyana* [*Forster PIF16701 & Figg* (BRI)]. N. *E. drummondii* [*Aplin 2205* (PERTH)]. O. *E. ferdinandi* var. *ferdinandi* [*Kalotas 354* (DNA)]. P. *E. ferdinandi* var. *appendiculata* [*Halford Q8604 & Thomas* (BRI)]. Q. *E. ferdinandi* var. *saxosiplaniticola* [*Badman 8796* (AD)]. R. *E. fitzroyensis* [*Thomson 3475* (NT)]. Scale bars = 1 mm.

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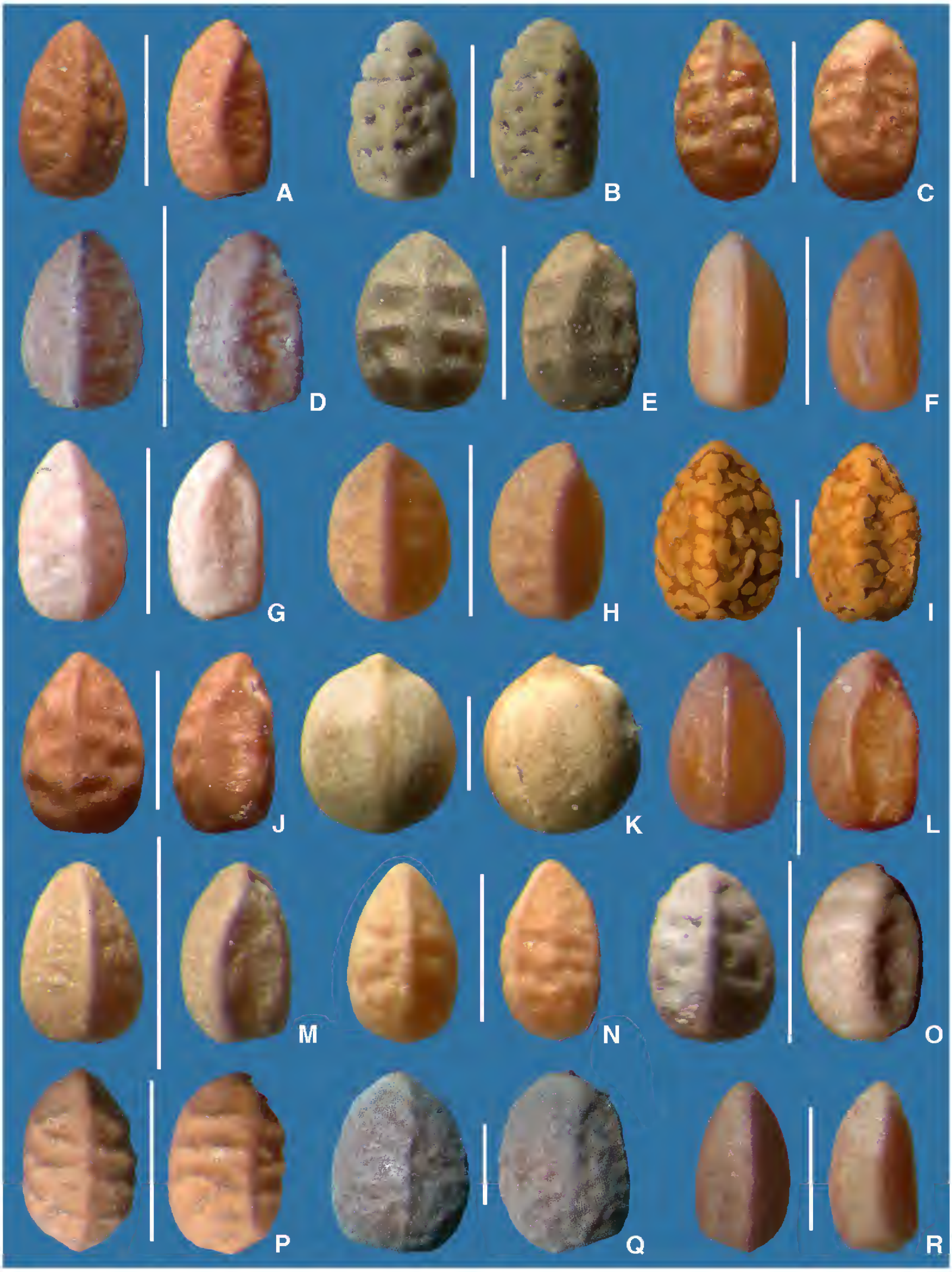
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Fig. 26.

← **Fig. 26.** Dorsal and lateral views of *Euphorbia* seeds: A. *E. flindersica* [*Kuchnel 3169* (AD)]. B. *E. gregoriensis* [*Thomson 1166* (DNA)]. C. *E. hassallii* [*Barritt 1700* (BRI)]. D. *E. hirta* [*Halford Q7478* (BRI)]. E. *E. hyssopifolia* [*Batianoff 981087* (BRI)]. F. *E. inappendiculata* var. *inappendiculata* [*Thomson 3503* (DNA)]. G. *E. inappendiculata* var. *queenslandica* [*Latz 3576* (DNA)]. H. *E. inappendiculata* var. *robustior* [*Kemp 890 & Fairfax* (BRI)]. I. *E. kimberleyensis* [*Kenneally 6704* (PERTH)]. J. *E. laciniloba* [*Halford Q8783 & Batianoff* (BRI)]. K. *E. litticola* [*Munir 6125* (BRI)]. L. *E. macdonaldii* var. *macdonaldii* [*McDonald KRM3913 & Little* (BRI)]. M. *E. macdonaldii* var. *potentillina* [*McDonald KRM3512* (BRI)]. N. *E. maconochieana* [*Perry & Lazarides 2025* (BRI)]. O. *E. maculata* [*Halford Q7512 & Batianoff* (BRI)]. P. *E. mitchelliana* var. *mitchelliana* [*Neldner 3843* (BRI)]. Q. *E. muelleri* [*Leach 3258* (DNA)]. R. *E. multifaria* (typical form) [*Donner 1684* (AD)]. Scale bars = 1 mm

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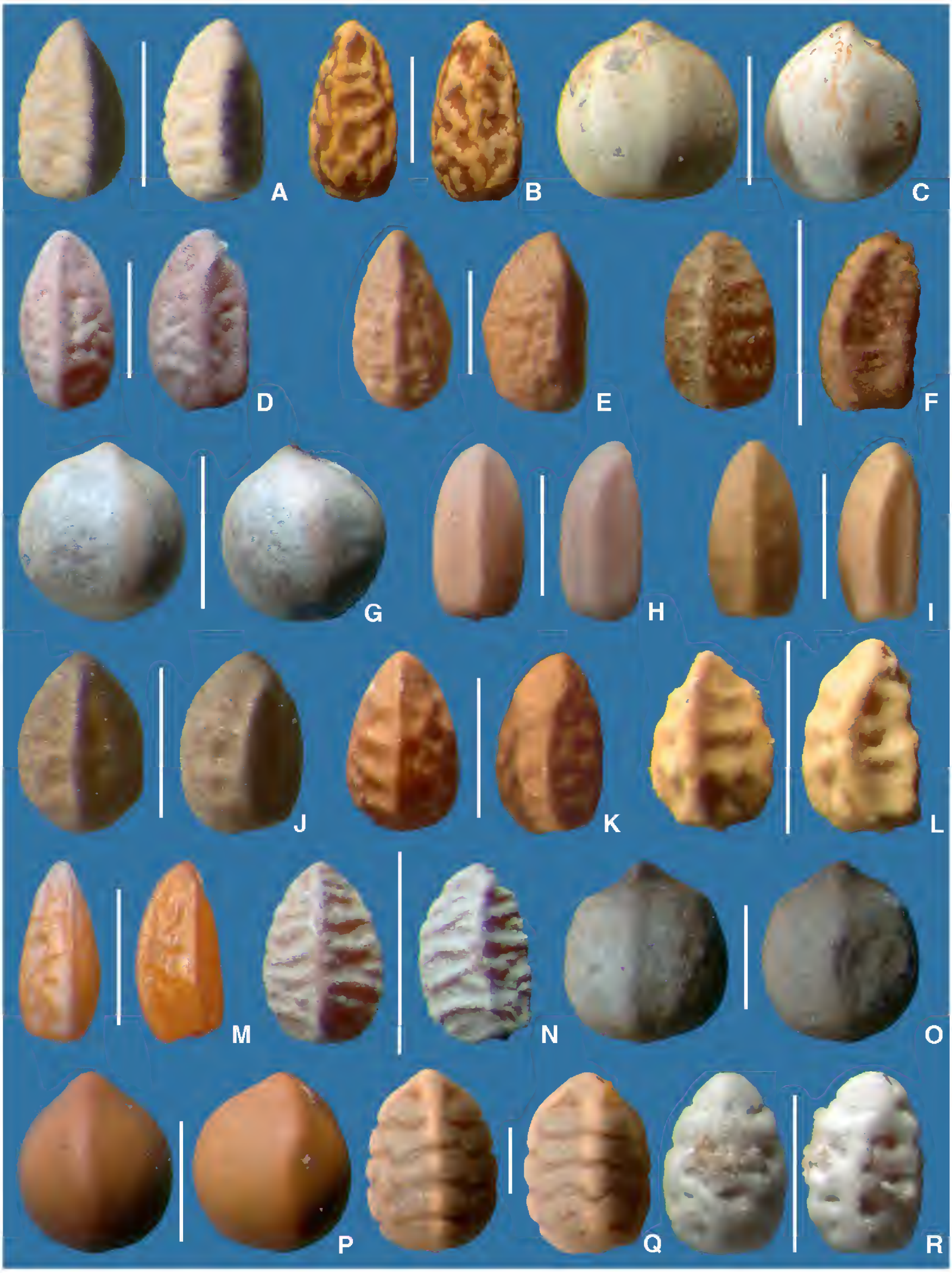
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Fig. 27.

← **Fig. 27.** Dorsal and lateral views of *Euphorbia* seeds: A. *E. multifaria* (Nullarbor form) [*Downing 987* (PERTH)]. B. *E. myrtoides* [*Halford Q9294* (BRI)]. C. *E. obliqua* [*Batianoff 205071* (BRI)]. D. *E. occulta* [*Booth 3536* (BRI)]. E. *E. ophiolitica* [*Forster PIF3393* (BRI)]. F. *E. ophthalmica* [*Batianoff 210201* (BRI)]. G. *E. pallens* [*Bean 3874* (BRI)]. H. *E. papillata* var. *papillata* [*Halford Q8597 & Thomas* (BRI)]. I. *E. papillata* var. *laevicaulis* [*Thompson & Wilson TAN551* (BRI)]. J. *E. papillifolia* [*McDonald KRM6036* (BRI)]. K. *E. petala* [*Halford Q607* (BRI)]. L. *E. philochalix* [*Thomson 3515* (DNA)]. M. *E. porcata* [*Hassall 7521* (BRI)]. N. *E. prostrata* [*Waterhouse BMW1444* (BRI)]. O. *E. psammogeton* [*Bean 12243* (BRI)]. P. *E. psilosperma* [*Thomson 2237* (DNA)]. Q. *E. schizolepis* [*Egan & Cowie 3238* (BRI)]. R. *E. schultzii* var. *schultzii* [*Simon 3986 & Cranfield* (BRI)]. Scale bars = 1 mm.

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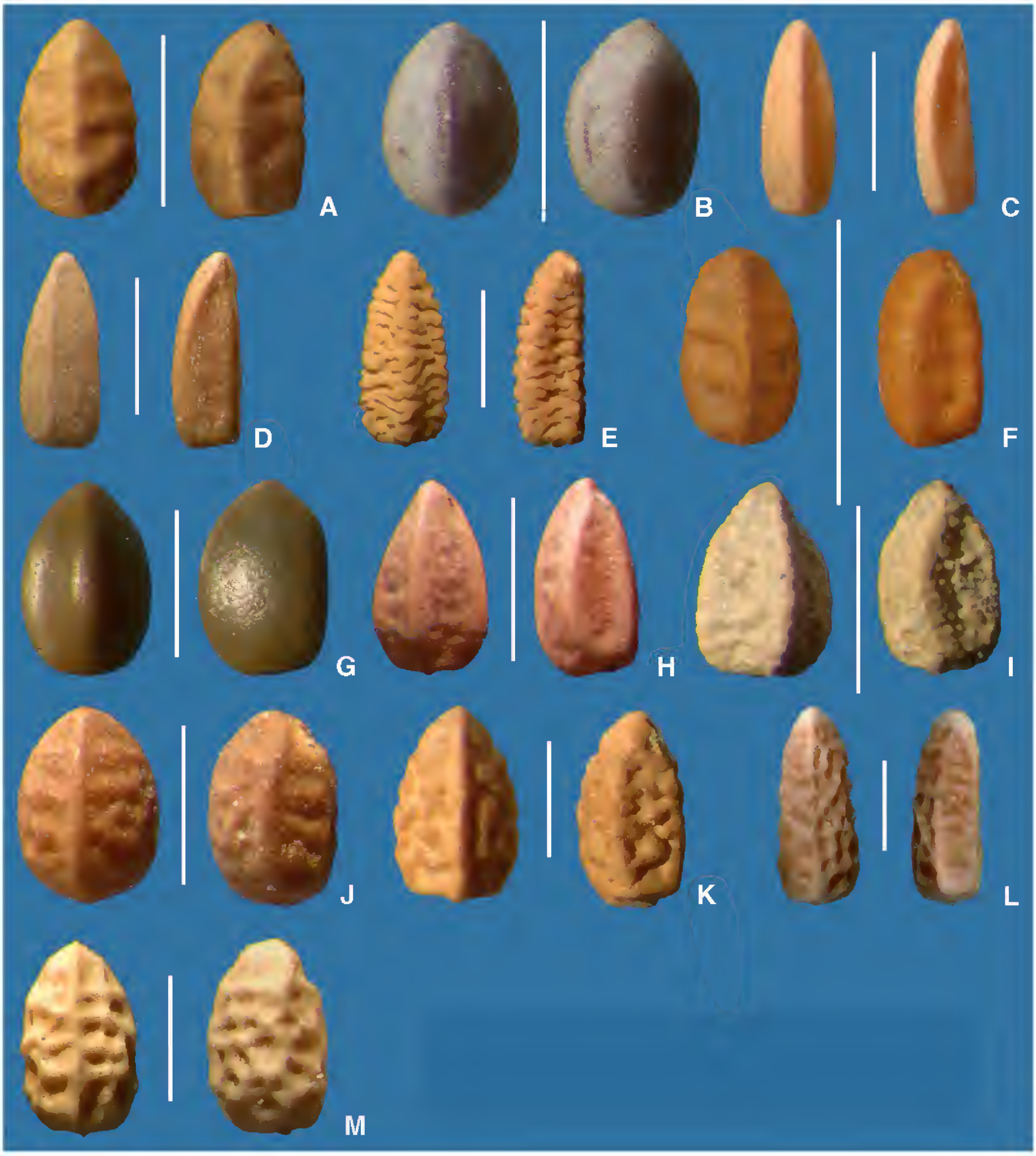
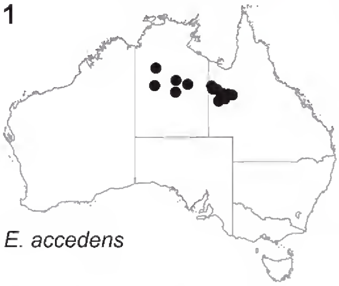


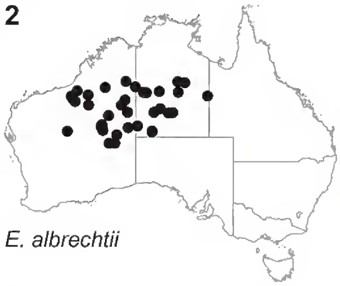
Fig. 28. Dorsal and lateral views of *Euphorbia* seeds: A. *E. schultzii* var. *comans* [*Henshall 3481* (BRI)]. B. *E. serpens* [*Halford Q8135 & Harris* (BRI)]. C. *E. thelephora* var. *thelephora* [*Neldner & Stanley 1870* (BRI)]. D. *E. thelephora* var. *australis* [*Jackson 5147* (AD)]. E. *E. thelephora* var. *rugosa* [*Nelson 2860* (DNA)]. F. *E. thymifolia* [*Clarkson 4597* (BRI)]. G. *E. trigonosperma* [*McDonald KRM4841* (BRI)]. H. *E. vaccaria* var. *vaccaria* [*Halford Q9181A* (BRI)]. I. *E. verrucitesta* [*Spooner 16298* (AD)]. J. *E. vicina* [*Willing 249* (PERTH)]. K. *E. victoriensis* [*Cleland s.n.* (AD 966060055)]. L. *E. wheeleri* (typical form) [*Hassall 7527* (BRI)]. M. *E. wheeleri* [*Bates 46879* (AD)]. Scale bars = 1 mm.

1



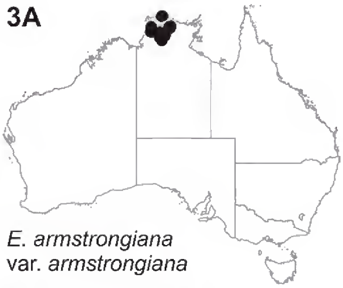
E. accedens

2



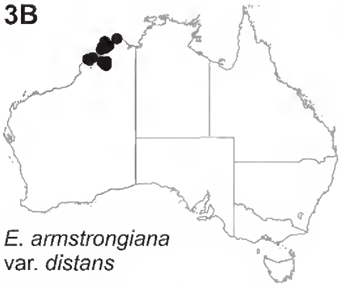
E. albrechtii

3A



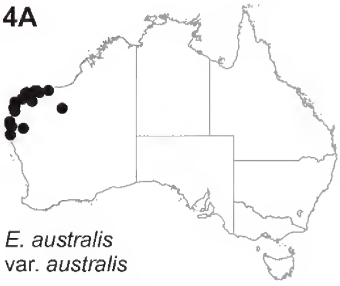
E. armstrongiana
var. *armstrongiana*

3B



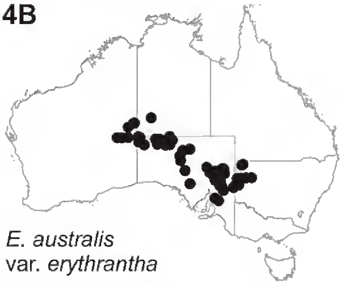
E. armstrongiana
var. *distans*

4A



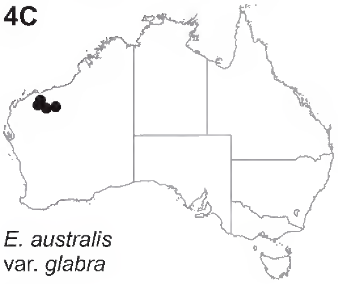
E. australis
var. *australis*

4B



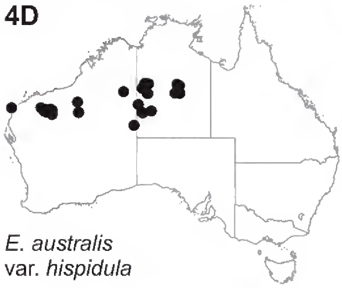
E. australis
var. *erythrantha*

4C



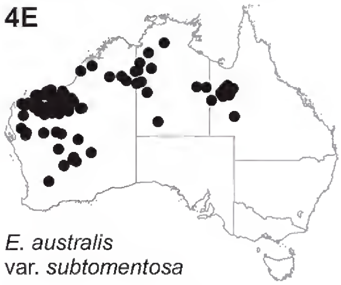
E. australis
var. *glabra*

4D



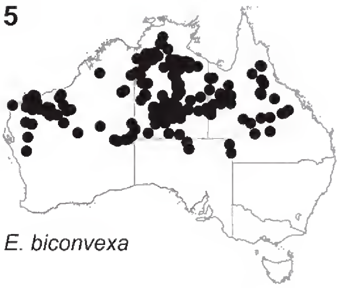
E. australis
var. *hispidula*

4E



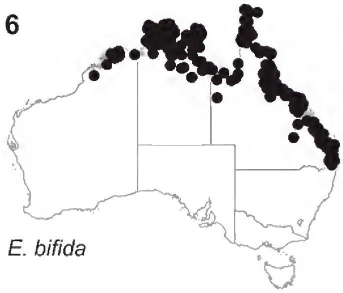
E. australis
var. *subtomentosa*

5



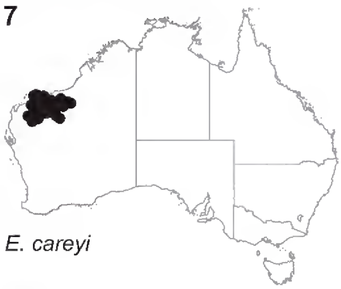
E. biconvexa

6



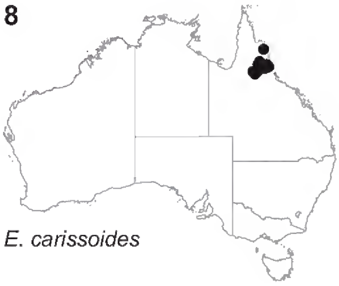
E. bifida

7



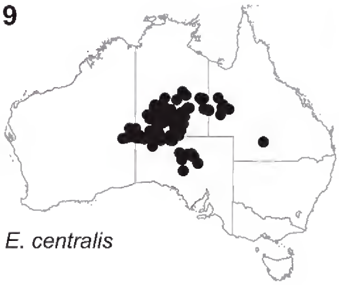
E. careyi

8



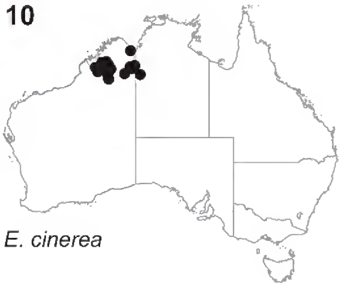
E. carissoides

9



E. centralis

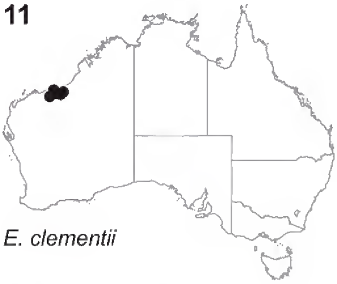
10



E. cinerea

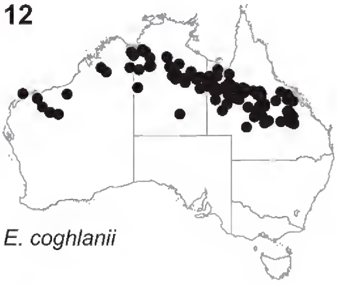
Maps 1-10.

11



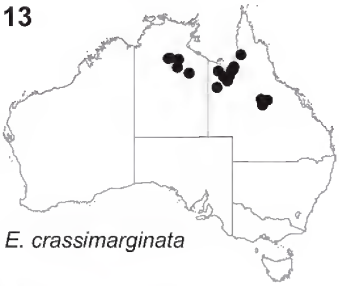
E. clementii

12



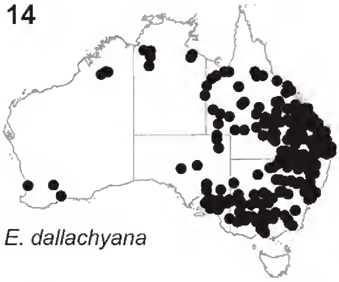
E. coghlanii

13



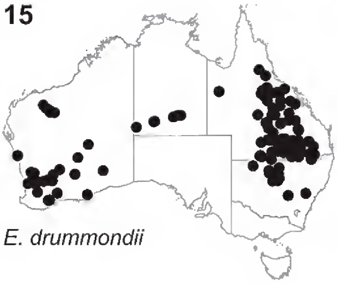
E. crassimarginata

14



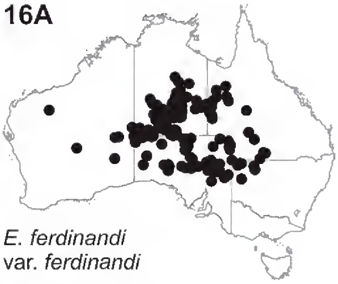
E. dallachyana

15



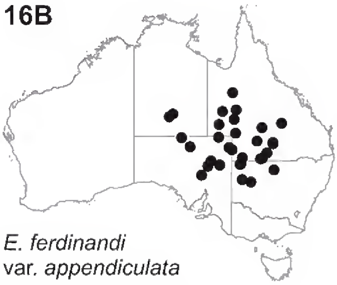
E. drummondii

16A



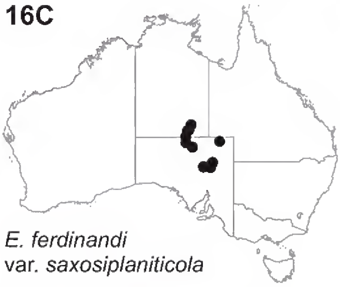
E. ferdinandi
var. *ferdinandi*

16B



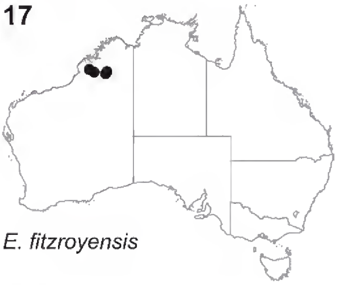
E. ferdinandi
var. *appendiculata*

16C



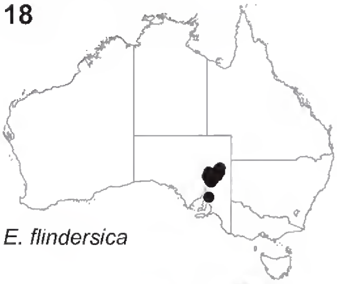
E. ferdinandi
var. *saxosiplaniticola*

17



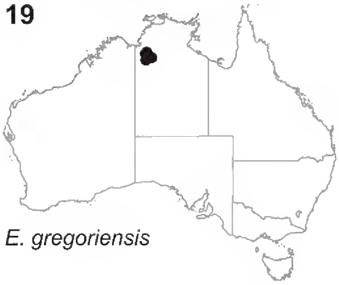
E. fitzroyensis

18



E. flindersica

19



E. gregoriensis

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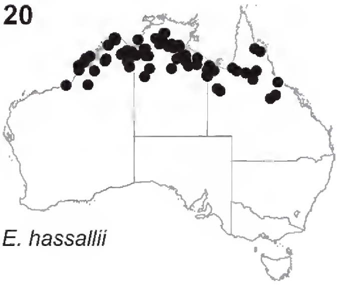
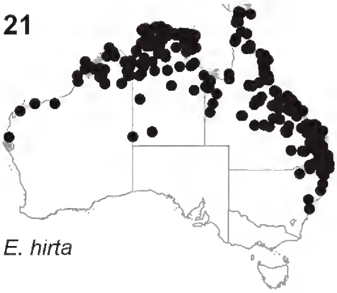


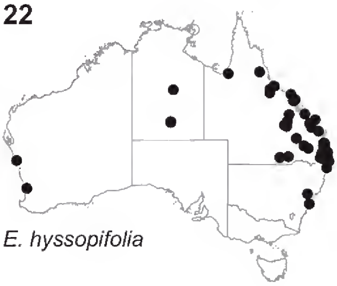
E. hassallii

21



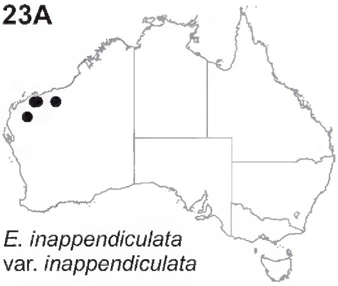
E. hirta

22



E. hyssopifolia

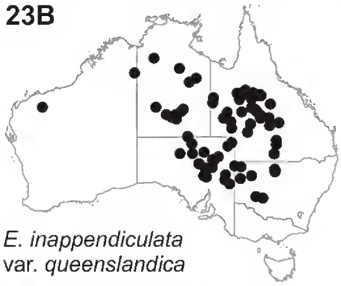
23A



E. inappendiculata
var. *inappendiculata*

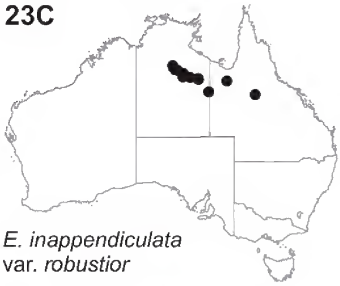
Maps 11-23A.

23B



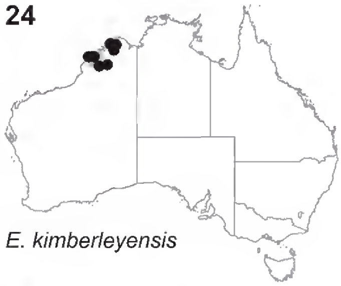
E. inappendiculata var. *queenslandica*

23C



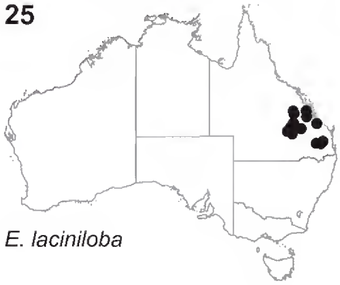
E. inappendiculata var. *robustior*

24



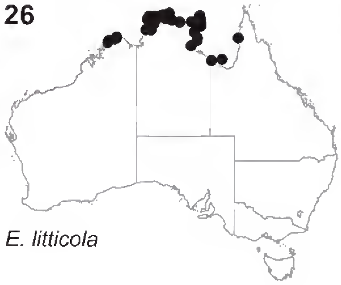
E. kimberleyensis

25



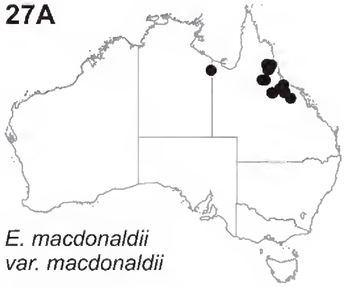
E. laciniloba

26



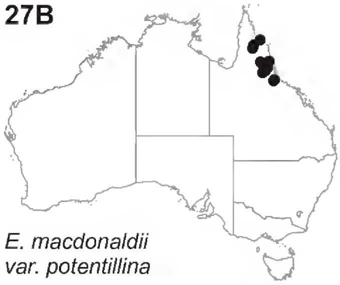
E. litticola

27A



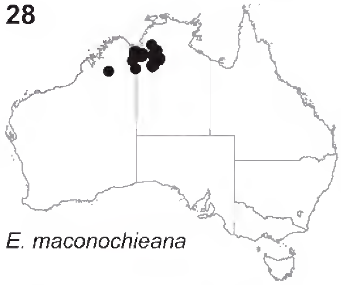
E. macdonaldii var. *macdonaldii*

27B



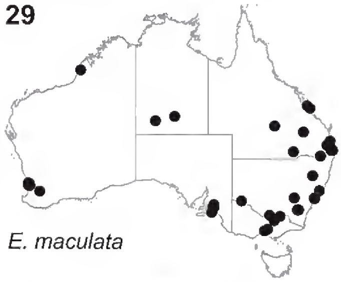
E. macdonaldii var. *potentillina*

28



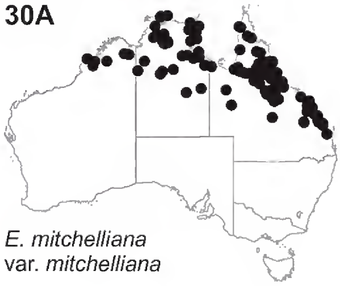
E. maconochieana

29



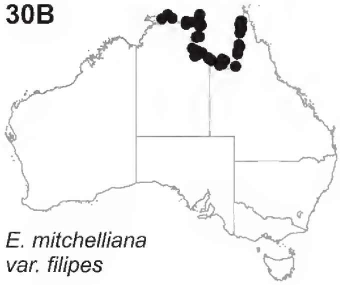
E. maculata

30A



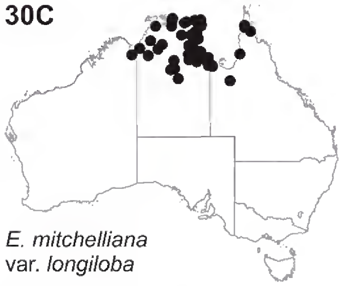
E. mitchelliana var. *mitchelliana*

30B



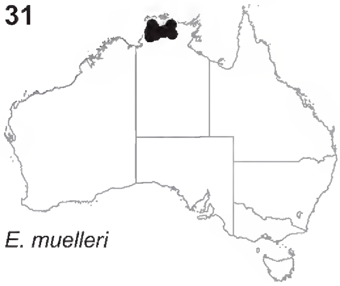
E. mitchelliana var. *filipes*

30C



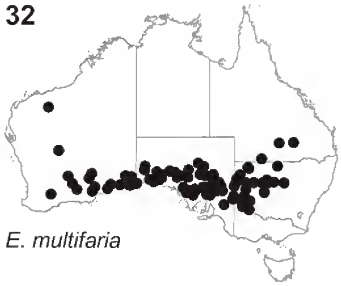
E. mitchelliana var. *longiloba*

31



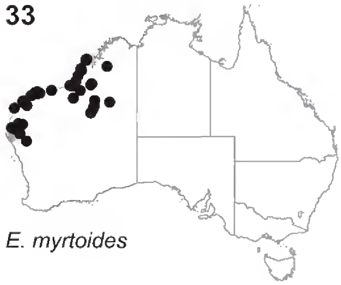
E. muelleri

32



E. multifaria

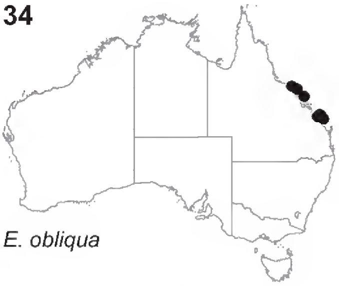
33



E. myrtoides

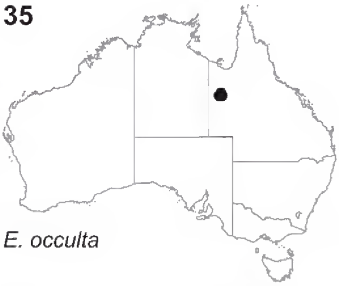
Maps 23B-33.

34



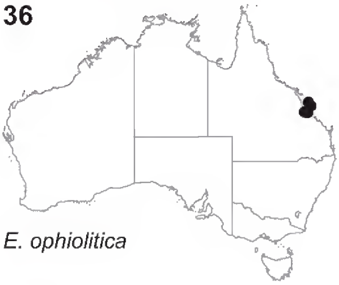
E. obliqua

35



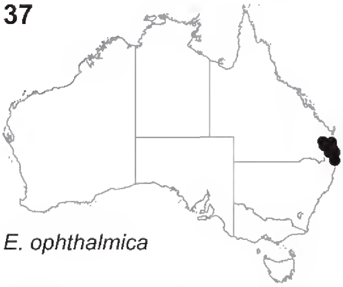
E. occulta

36



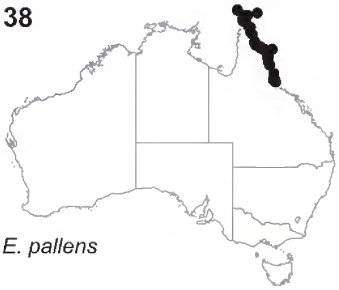
E. ophiolitica

37



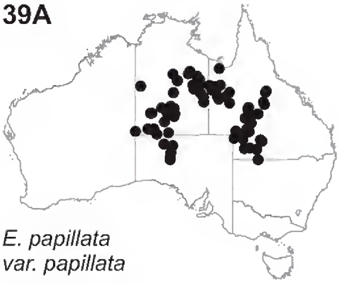
E. ophthalmica

38



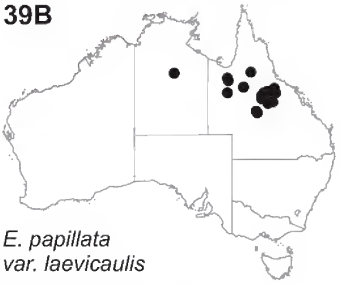
E. pallens

39A



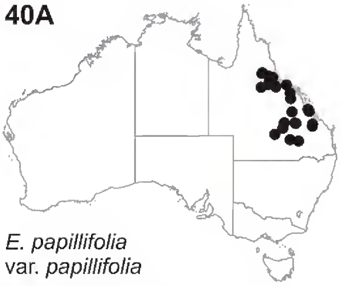
E. papillata var. *papillata*

39B



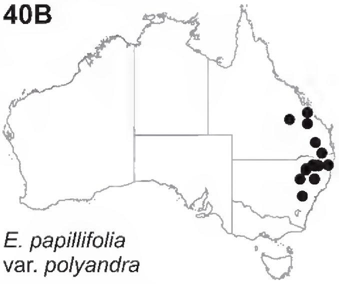
E. papillata var. *laevicaulis*

40A



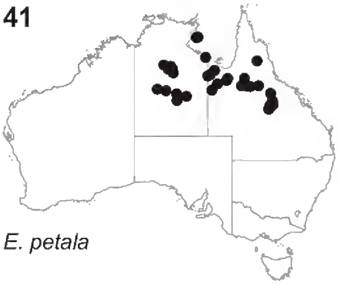
E. papillifolia var. *papillifolia*

40B



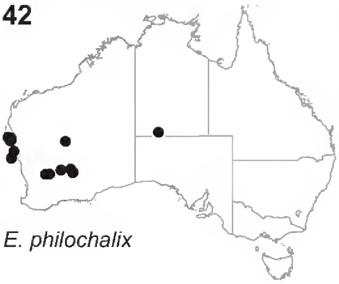
E. papillifolia var. *polyandra*

41



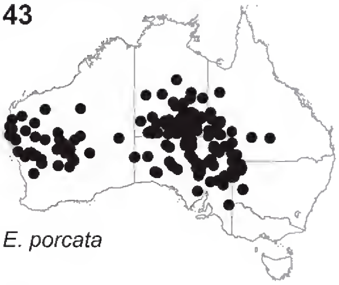
E. petala

42



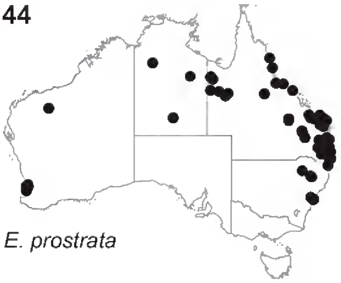
E. philochalix

43



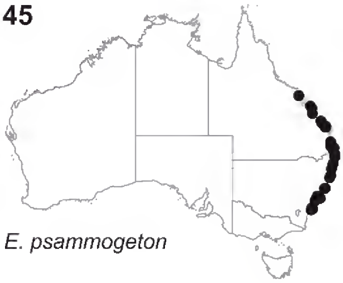
E. porcata

44



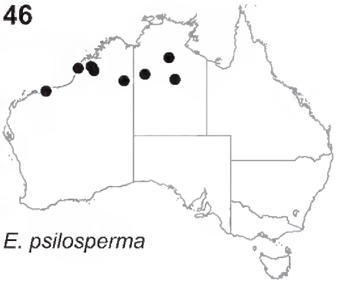
E. prostrata

45



E. psammogeton

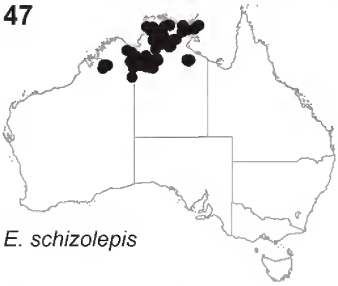
46



E. psilosperma

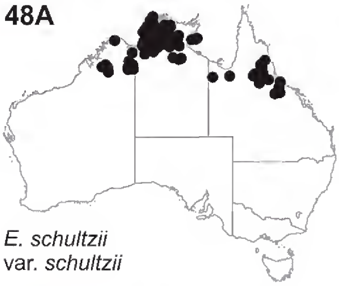
Maps 34-46.

47



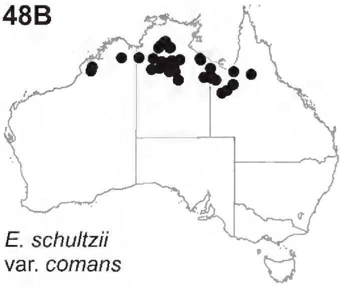
E. schizolepis

48A



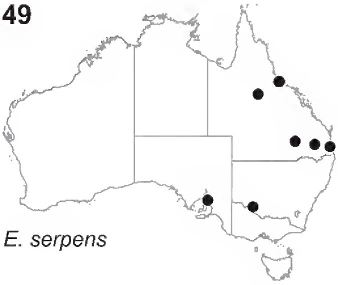
E. schultzii
var. *schultzii*

48B



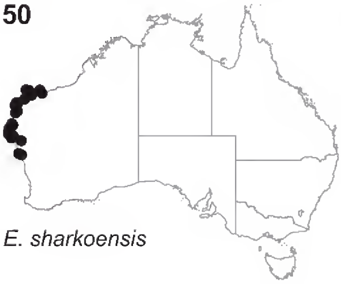
E. schultzii
var. *comans*

49



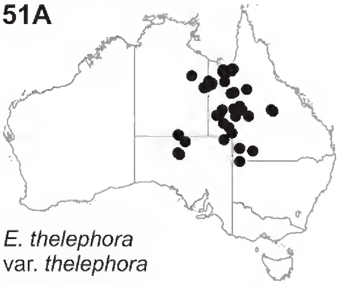
E. serpens

50



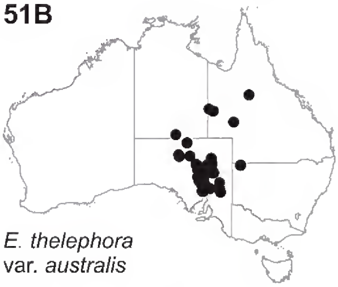
E. sharkoensis

51A



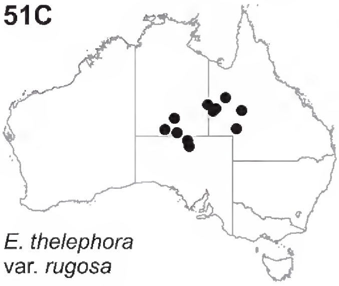
E. thelephora
var. *thelephora*

51B



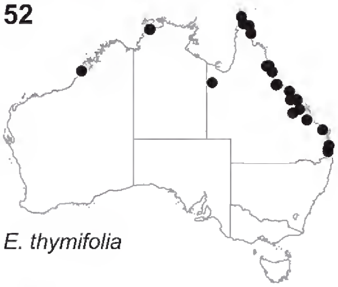
E. thelephora
var. *australis*

51C



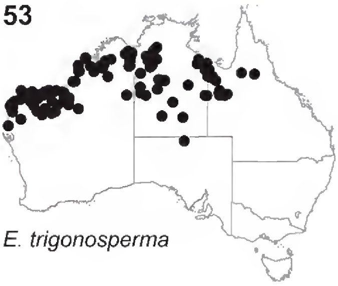
E. thelephora
var. *rugosa*

52



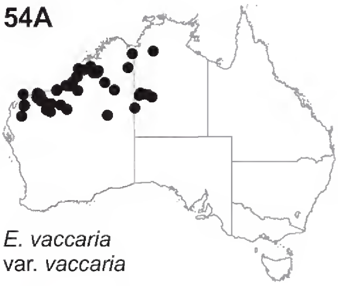
E. thymifolia

53



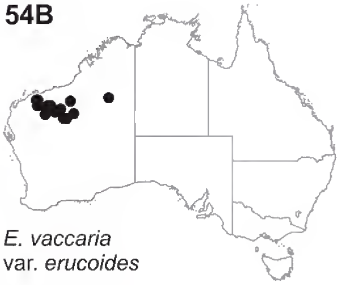
E. trigonosperma

54A



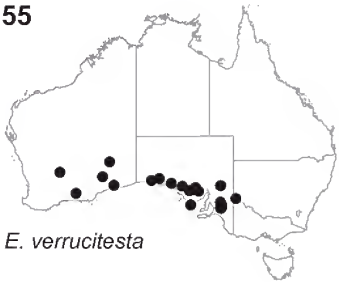
E. vaccaria
var. *vaccaria*

54B



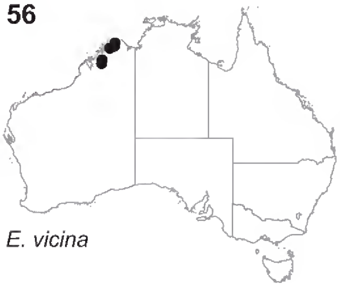
E. vaccaria
var. *erucoides*

55



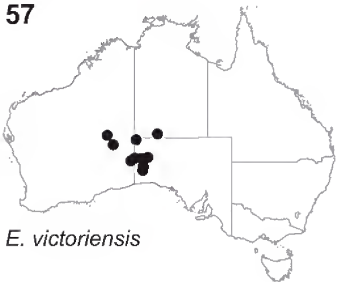
E. verrucitesta

56



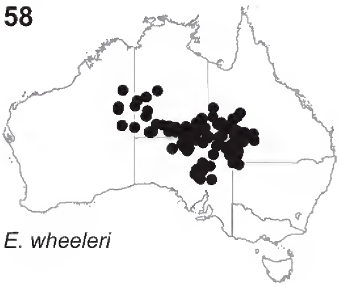
E. vicina

57



E. victoriensis

Maps 47-57.



Map 58.

Appendix 1. List of chromosome numbers for Australian taxa of *Euphorbia* sect. *Anisophyllum* (data from Hassall 1977 and BRI database).

Taxon	***n*=**	**Queensland Herbarium AQ number of voucher specimens**
E. australis var. *erythrantha*	11	475107
E. australis var. *subtomentosa*	11	475110, 475112, 475113, 478151
E. biconvexa	8	475032, 475033, 475037, 475041, 475042, 475043, 475044, 475045, 475046
E. bifida (coastal form)	8	475047, 475048, 475050, 475088
E. bifida (narrow leaf form)	8	475072, 475074, 475075
E. coghlanii	8	475034, 475035, 475036, 475038, 475057
E. crassimarginata	11	475165, 475167, 475168
E. dallachyana	11	475134, 475135, 475136, 475137, 475138, 475139, 475140, 475141, 475142, 475143, 475144, 475145, 475146, 475147, 475148, 475150,475151, 475152, 475153, 475154, 475155, 475156, 475157, 475170
E. dallachyana	22	447303, 447304, 447305, 447306, 447311, 447317, 447318, 447319, 447320,447321, 447322, 447323, 447327, 447278, 447279, 475115, 475116, 475117, 475118, 475121
E. drummondii	11	447280, 447300, 447301, 447307, 447308, 447309, 447310, 447312, 447325, 447326, 447328, 447330, 447331, 447332, 447333, 447334, 447335, 447337, 447339, 447345, 447346, 447347, 447348, 475085, 475087, 475163, 475164
E. ferdinandi var. *ferdinandi*	11	475097, 475098, 475099, 475100, 475101, 475103
E. ferdinandi var. *appendiculata*	11	447284, 447289, 447290, 447292

Taxon	***n*=**	**Queensland Herbarium AQ number of voucher specimens**
E. flindersica	11	475128
E. hassallii	11	475125, 475127
E. inappendiculata var. *queenslandica*	11	447283, 447298, 447343, 475122, 475123, 475161
E. macdonaldii var. *potentillina*	11	475106
E. mitchelliana var. *longiloba*	8	475055, 475058
E. mitchelliana var. *mitchelliana*	8	475054, 475059, 475060, 475062, 475061, 475063, 475064,475065, 475066
E. multifaria	11	447287, 447288, 447295, 447296, 447313, 447314, 447315, 447336
E. papillata var. *papillata*	11	475093, 475096, 475104
E. papillifolia var. *polyandra*	11	475129
E. philochalix	11	475130, 475131, 475132
E. porcata	11	447299, 447294, 475120, 447324, 447285, 447316, 447286, 447282, 447297
E. psammogeton	8	475049
E. schultzii	11	475105
E. thelephora var. *rugosa*	11	475111
E. thelephora var. *thelephora*	11	475069, 475070, 475071, 475095
E. wheeleri	11	475080, 475082,475083, 475084, 475077, 475078, 475079, 475240

Index to Scientific Names

Names in **bold** type are accepted names and those in light type are synonyms, *etc.* The numbers refer to the taxa enumerated above and excl. refers to ‘Excluded names’ section.

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Chamaesyce biconvexa (Domin) D.C.Hassall 5
Chamaesyce bifida (Hook. & Arn.) T.Kuros. 6
Chamaesyce carissoides (F.M.Bailey) P.I.Forst. & R.J.F.Hend.. 8
Chamaesyce centralis (B.G.Thomson) P.I.Forst. & R.J.F.Hend.. 9
Chamaesyce coghlanii (F.M.Bailey) D.C.Hassall ex P.I.Forst. & R.J.F.Hend. 12
Chamaesyce dallachyana (Baill.) D.C.Hassall 14
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Chamaesyce macgillivrayi (Boiss.) D.C.Hassall 6
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Chamaesyce micradenia (Boiss.) D.C.Hassall 6
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Euphorbia australis var. ***glabra*** Halford & W.K.Harris 4c

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Euphorbia macgillivrayi var. *filipes* (Benth.) Domin . . . 30b
Euphorbia macgillivrayi Boiss. var. *macgillivrayi* . . . 6
Euphorbia macgillivrayi var. *micradenia* (Boiss.) Domin. . . . 6
Euphorbia macgillivrayi var. *pseudoserrulata* Domin . . . 6
Euphorbia macgillivrayi var. *yarrabensis* Domin . . . 6
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Euphorbia maculata L. . . . 29
Euphorbia micradenia Boiss. . . . 6
Euphorbia minutifolia Boiss. . . . 14
Euphorbia mitchelliana Boiss. . . . 30
Euphorbia mitchelliana var. *cairnsiana* Domin . . . 30a
Euphorbia mitchelliana var. *dietrichiae* Domin . . . 30a
Euphorbia mitchelliana var. *filifolia* Domin . . . 30a
Euphorbia mitchelliana var. ***filipes*** (Benth.) Halford & W.K.Harris . . . 30b
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Euphorbia mitchelliana Boiss. var. ***mitchelliana*** . . . 30a
Euphorbia mitchelliana var. *oblongifolia* Boiss. . . . 30a
Euphorbia mitchelliana var. *stenophylla* Benth. . . . 6
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Utricularia corneliana R.W.Jobson (Lentibulariaceae), a new species from the North Kennedy district of Queensland

Richard W. Jobson

Summary

Jobson, R.W. (2012). *Utricularia corneliana* R.W.Jobson, (Lentibulariaceae), a new species from the North Kennedy district of Queensland. ***Austrobaileya* 8(4): 601–607.** *Utricularia corneliana* R.W.Jobson, possibly endemic to the Minnamoolka area of northern Queensland, is described, illustrated, and differentiated from the local, and closely related African and South American species. Notes are provided on habitat and ecology, and conservation status. A key to Australian and related suspended aquatic species of *Utricularia* is provided.

Key Words: Lentibulariaceae, *Utricularia*, *Utricularia corneliana*, Australia flora, Queensland flora, new species, taxonomy, bladderwort, aquatic

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Introduction

Utricularia L. (Lentibulariceae) is a monophyletic genus of carnivorous angiosperms containing at least 219 recognised species worldwide (Taylor 1989; Gassin 1993; Lowrie 1998, 2002; Lowrie *et al.* 2008; Jobson 2012), mostly distributed in subtropical and tropical regions (Taylor 1989). In his monograph of *Utricularia*, Taylor (1989) delimited the genus into the following two subgenera: *Polypompholyx* (Lehm.) P.Taylor (three species), including two sections (*Tridentaria* P.Taylor and *Polypompholyx*), and *Utricularia* (211 species), including 35 sectional groupings. In line with the results of Jobson *et al.* (2003) the genus has since been divided into three subgenera, viz. *Polypompholyx*, *Bivalvaria* S.Kurz and *Utricularia* (Reut & Jobson 2010). Australia has *c.* 62 species (47 endemic), from the subgenera *Polypompholyx* (*c.* 40 species), *Bivalvaria* (13 species), and *Utricularia* (nine species).

Based on its suspended aquatic habit, and morphological characters such as bladder-trap form, the absence of bracteoles, the presence of basifixed bracts, and dehiscence of seed via a circumscissile suture of the capsule, the new species described here (*Utricularia corneliana*, **Figs. 1, 2A**) is considered a member of subgenus *Utricularia* section *Utricularia*. This section consists mainly of species with a fully suspended aquatic habit (Taylor 1989; Jobson *et al.* 2003). In the current paper, the distribution, habitat and morphological differences between *U. corneliana* and the other Australian suspended aquatic species, *U. aurea* Lour., *U. australis* R.Br., *U. gibba* L., *U. muelleri* Kamiénski, and *U. stellaris* L.f., are discussed. Also provided is a comparative discussion of the tropical African *U. reflexa* Oliver and *U. raynalii* P.Taylor, and the South American *U. warmingii* Kamiénski, three species that have several characters in common with *U. corneliana*.

Methods and materials

This study is based on a single collection from a single site. The specimen was divided into two spirit preserved (70% ethanol) accessions that are deposited at NSW and BRI.

The author examined suspended aquatic species of *Utricularia* (*U. aurea*, *U. australis*, *U. gibba*, *U. muelleri* and *U. stellaris*) that are deposited at BRI and NSW, finding no indication that wrongly identified *U.*

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corneliana had previously been collected.

Taxonomy

Utricularia corneliana R.W.Jobson, **species nova** *U. reflexae* similis sed limbo inferiore quam superiore majore differt. **Typus:** Australia: Queensland. North Kennedy District: S of Mt Garnet, 9 June 2011, *R.W.Jobson 1281* (holo: NSW; iso: BRI).

Small perennial, suspended aquatic herb. **Rhizoids** not present. **Stolons** filiform 5–15 cm long, 0.3–0.5 mm thick, unbranched, terete, sparsely hairy, internodes 6–8 mm long. **Leaves** numerous, circular in outline, ± amplexicaul, 3–5 mm long, slightly flattened, divided at the base into 2 primary segments, with 3 further dichotomously divided segments, the ultimate segments apically and laterally setulose. **Traps** 1 (2) per leaf, inserted in the angle between the first and second division segments, occasionally also in the third, stalked, ovoid 2–2.6 mm long, mouth lateral with two dorsal, setiform, often recurved appendages 1–2 mm long, sometime 2 or 3 simple lateral setae. Internal glands 4-armed, narrowly cylindrical up to 90 µ long, ~5 µ in diameter (**Fig. 2B**). **Inflorescence** weakly erect, emergent, 2–3 cm long, arising along the stolon from nodes at intervals of *c.* 3.5 cm. Peduncle filiform 0.5–0.6 mm thick, terete, glandular, sparsely hairy on lower portion, mostly glabrous above first bract. Scales and bracteoles absent. Bracts basifixed, amplexicaule, *c.* 1.3 mm long and 0.9 mm in diameter, apex rounded or truncate. **Flowers** 1–3 on an elongated raceme axis; pedicels filiform, erect at anthesis, deflexed in fruit 3–5.5 mm long. Lowest flower probably cleistogamous. Calyx lobes subequal, upper lobe slightly longer, ovate 3–3.5 mm long, 2–2.2 mm in diameter. **Corolla** 4.5–9.3 mm long, yellow, with few brown nerves on the basal portion of the upper lip, densely covered with fine multicellular hairs on dorsal surfaces; upper lip broadly ovate with apex rounded 4–6.5 mm long, 3.8–5.5 mm in diameter, the lower half of dorsal surface covered in hairs; lower lip limb smaller, bilobed, with a single prominent, slightly emarginate swelling at the base; spur cylindrical at base, curved, slightly flattened and tapering mid-way with apex rounded, almost as long as lower lip (when lip is flattened). **Filaments** curved *c.* 1.6 mm long. **Ovary** globose. Capsule 3.2–3.7 mm long, 2–3 mm in diameter, walls fleshy, circumscissile dehiscence. **Seeds** thinly lenticular 0.8–1 mm in diameter, with a broad, softly angled and translucent, mildly dentate edged, marginal wing of irregular testa cells with raised anticlinal walls (**Fig. 2C**). Pollen 17–18 colporate, 30 × 30 µ, *Jobson 1281* (NSW). **Fig. 1.**

***Distribution and habitat*:** *Utricularia corneliana* is thus far, only known from a single Swamp, south of Mt Garnet in the Minnamoolka area. This ephemeral swamp with a circumference of *c.* 4 km is fringed by *Eucalyptus platyphylla* F.Muell., *E.* sp., and *Melaleuca nervosa* (Lindl.) Cheel woodland (**Fig. 3**). Plants of the bladderwort were infrequent in a single corner of the swamp (*c.* 5 × 5 m), in water to *c.* 20 cm deep, with *Aldrovanda vesiculosa* L., aquatic grasses, *Eleocharis* sp., *Marsilea mutica* Mett., *Myriophyllum simulans* Orchard, *Nympoides indica* (L.) Kuntze, *Utricularia aurea*, *U. gibba* and *U. stellaris*. This black soil swamp is based upon a basalt and sand substrate at an elevation of *c.* 700 m.

***Phenology*:** Flowers and fruits recorded in June. Further research is required to determine extent of flowering season.

***Notes*:** *Utricularia corneliana* is geographically isolated and grows sympatrically with three other suspended aquatic *Utricularia* species; however, morphologically it shares most characters in common with *U. reflexa*, a variable species endemic to tropical Africa and Madagascar (Taylor 1989: fig. 194, p. 640). Molecular phylogenetic data also support this relationship (Jobson *et al*., in prep.) and negate the possibility of a localised hybridisation event. These two species share a bright yellow corolla, similarly shaped bracts, bilobed lower corolla lip, and have traps invariably positioned at the angle between leaf segments (**Fig. 1**).

There are two, perhaps closely allied species, that also have traps positioned in the angle between leaf segments; *Utricularia raynalii* (tropical Africa) (Taylor 1989: fig. 195, p. 642), and *U. warmingii* (South America) (Taylor 1989: fig. 196, p. 644). These two species differ from *U. reflexa* and *U. corneliana* by both possessing prismatic shaped seeds; a rose pink corolla and spongy lower leaf segments in the former and a light yellow corolla and inflated peduncles in the latter (Taylor 1989).

There are several characters that differentiate *Utricularia corneliana* from *U. reflexa*, namely a lack of rhizoids in the former; an upper corolla lip that is longer than the lower, with an upper lip rear surface sparsely hairy only on the lower half (**Fig. 1**), versus an entirely hairy surface in *U. reflexa* (Taylor 1989: fig. 194, p. 640); internal trap quadrifid gland arms that are 14 versus 30 times as long as they are wide (**Fig 2B**, versus Taylor 1989: fig. C, p. 17); flat lenticular shaped seeds (*c.* 1 mm in diameter) (**Fig. 1, 2C**), versus disc shaped seeds (0.4–0.8 mm in diameter) that are 2–3 times wider than thick (Taylor 1989: fig. 194, p. 640).

***Conservation status*:** After a search along the circumference of the type locality swamp (**Fig. 3**), plants were not observed anywhere else. Two nearby swamps (*c.* 10 and 15 km away respectively) were also examined with no other sightings.

Considering the limited geographic distribution of *Utricularia corneliana* and its low frequency at the collection site, it is likely that this plant is extremely rare. The collection site is on leasehold land and is therefore not protected.

If *Utricularia corneliana* is more widespread than appears, the question remains as to why it had not been collected before this study? One possible answer is that the flowers of *U. corneliana* resemble those of other local *Utricularia* species (*U. aurea*, *U. gibba*, and *U. stellaris*) in the general shape and colour (yellow), blending in with these more common species.

It could also be the case that habitat destruction, erosion, weed infestation, and associated eutrophication of swamps and lagoons, early on in the agricultural history of the region, has reduced the population size of *Utricularia corneliana*. An example of a local disappearance of a fellow suspended aquatic species is that of *U. tubulata* F.Muell., the type specimen of which (*Armit 222* [MEL1513562]) was collected in 1875 on ‘Cashmere’ (now ‘Glen Ruth’ and ‘Goshen’ stations), about 15 km E of the *U. corneliana* site. Armit recorded the plant as “floating in swamps and lagoons” on “Cashmere”, but it has not since been collected anywhere in Queensland, except for a single site in the far north-west corner of the state (*Jacobs 1465* [NSW]).

A more intensive survey of this area of Queensland is warranted to determine presence and extent of both the above species; although it is likely that *Utricularia corneliana* has mostly suffered the same early fate as that of the local *U. tubulata*. At present the conservation status of *U. corneliana* should be regarded as Data Deficient.

***Etymology*:** The specific epithet is in honour of Cornelia M. Jobson, the author’s wife and field assistant.

Acknowledgements

I thank Roderick Fensham and Peter Bostock (BRI) for providing information on specimens. I also thank Catherine Wardrop for providing the detailed illustrations presented in this paper, Peter Wilson for preparing the Latin diagnosis, Marco Duretto for providing helpful comments on the manuscript (all NSW), Lubomir Adamec (Czech Republic) for supplying plant material, and Cornelia Jobson for help with fieldwork. Scientific Purposes permits were obtained through the Queensland Department of Environment and Resource Management (WITK08454010, WISP08454110). This work was partly supported by ABRS grant RFL212-45.

Key to Australian and related suspended aquatic species of *Utricularia* (modified from Taylor 1989)

Abbreviations: NSW (New South Wales), Qld (Queensland), NT (Northern Territory), SA (South Australia), Tas (Tasmania), WA (Western Australia)

1 Leaves verticillate; peduncle inflated; corolla very pale pink with a very slender spur 1.5–2 cm long . . . . **U. tubulata** (Qld, NT, WA)
1. Leaves not verticillate (some semiverticillate); peduncle not inflated; corolla yellow. **2**

2 Peduncle with whorl of usually inflated leaf-like structures at or above base; primary segments of leaves 3–6 . . . . **3**
2. Peduncle without a whorl of inflated leaf-like organs; primary segments of leaves 2 . . . . **5**

3 Inflated leaf-like organs fusiform, arising from base, or near base of peduncle . . . . **U. aurea** (NSW, Qld, NT, WA)
3. Inflated leaf-like organs ellipsoid, arising some distance above base of peduncle **4**

4 Inflated leaf-like organs sessile with capillary segments arising from distal half only; seeds disk shaped, angular (not winged); calyx about equal in length to capsule. . . . .**U. stellaris** (NSW, Qld, NT, WA)
4. Inflated leaf-like organs stipitate with capillary segments arising from distal half and from base; seeds lenticular, narrowly winged; calyx much shorter than capsule . . . . **U. muelleri** (Qld, NT, WA)

5 Corolla externally pubescent; traps always inserted at angle between leaf segments **6**
5. Corolla externally glabrous; traps lateral on leaf segments **7**

6 Corolla upper lip longer than lower; seed flat, lenticular. . . . . **U. corneliana** (Qld)
6. Corolla upper lip equal to or shorter than lower; seed thick, disk-shaped. . . . . **U. reflexa** (tropical Africa, Madagascar)

7 Leaves with ultimate segments few (2–8); upper corolla lip larger than lower . . . . **U. gibba** (All states except SA, Tas)
7. Leaves with ultimate segments numerous (20–80); upper corolla lip smaller than lower . . . . **U. australis** (All states)

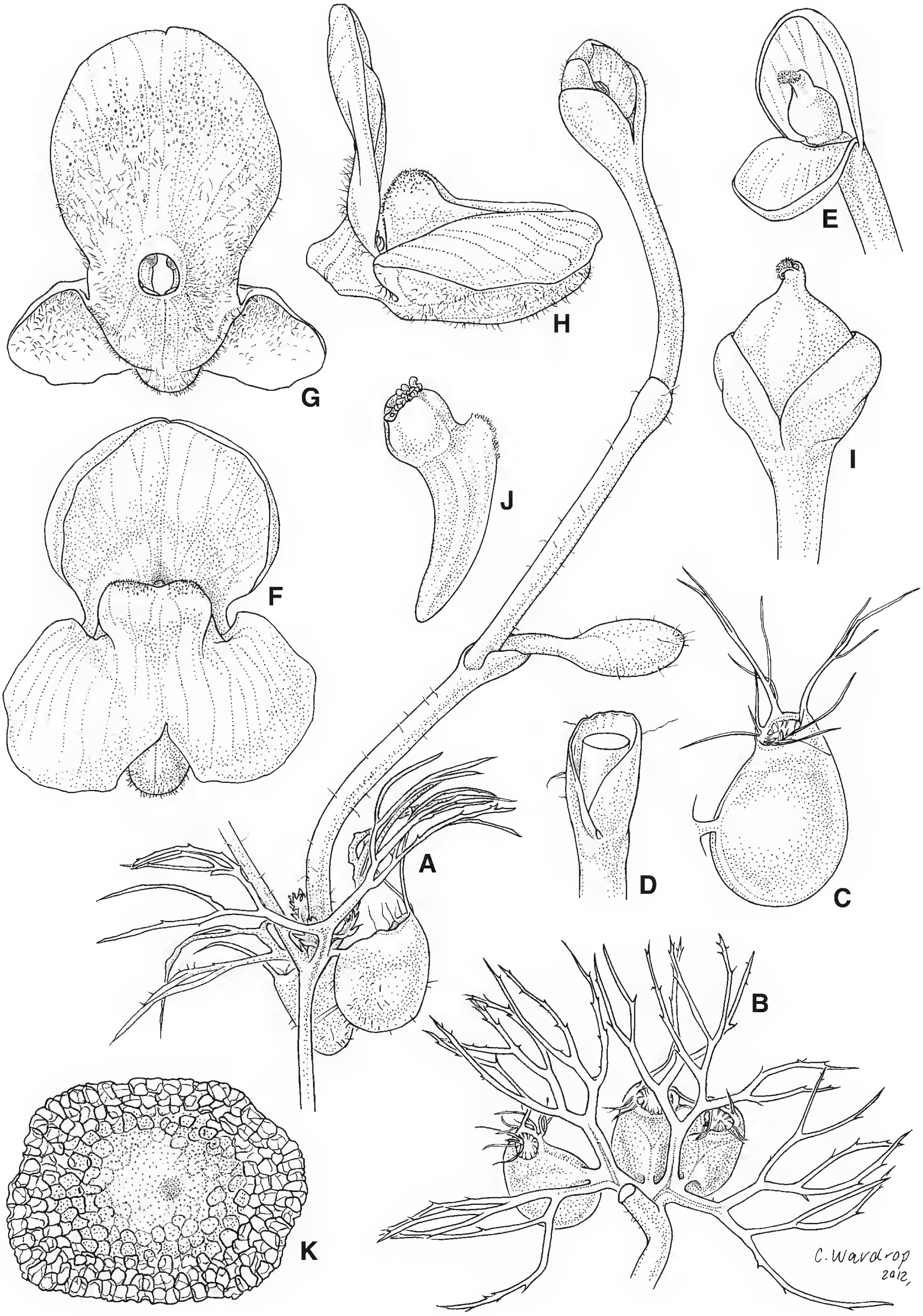

Fig. 1. ***Utricularia corneliana.*** A. habit ×5.5. B. leaf segments with traps ×7. C. bladder-trap in lateral view ×10. D. bract with pedicel base *in situ* ×10. E. sepals with exposed ovary ×7. F. flower in frontal view ×5.5. G. flower in rear view ×5.5. H. flower in lateral view ×5.5. I. fruiting capsule with calyx ×7. J. stamen ×20. K. seed ×40. A–K from *Jobson 1281* (NSW).

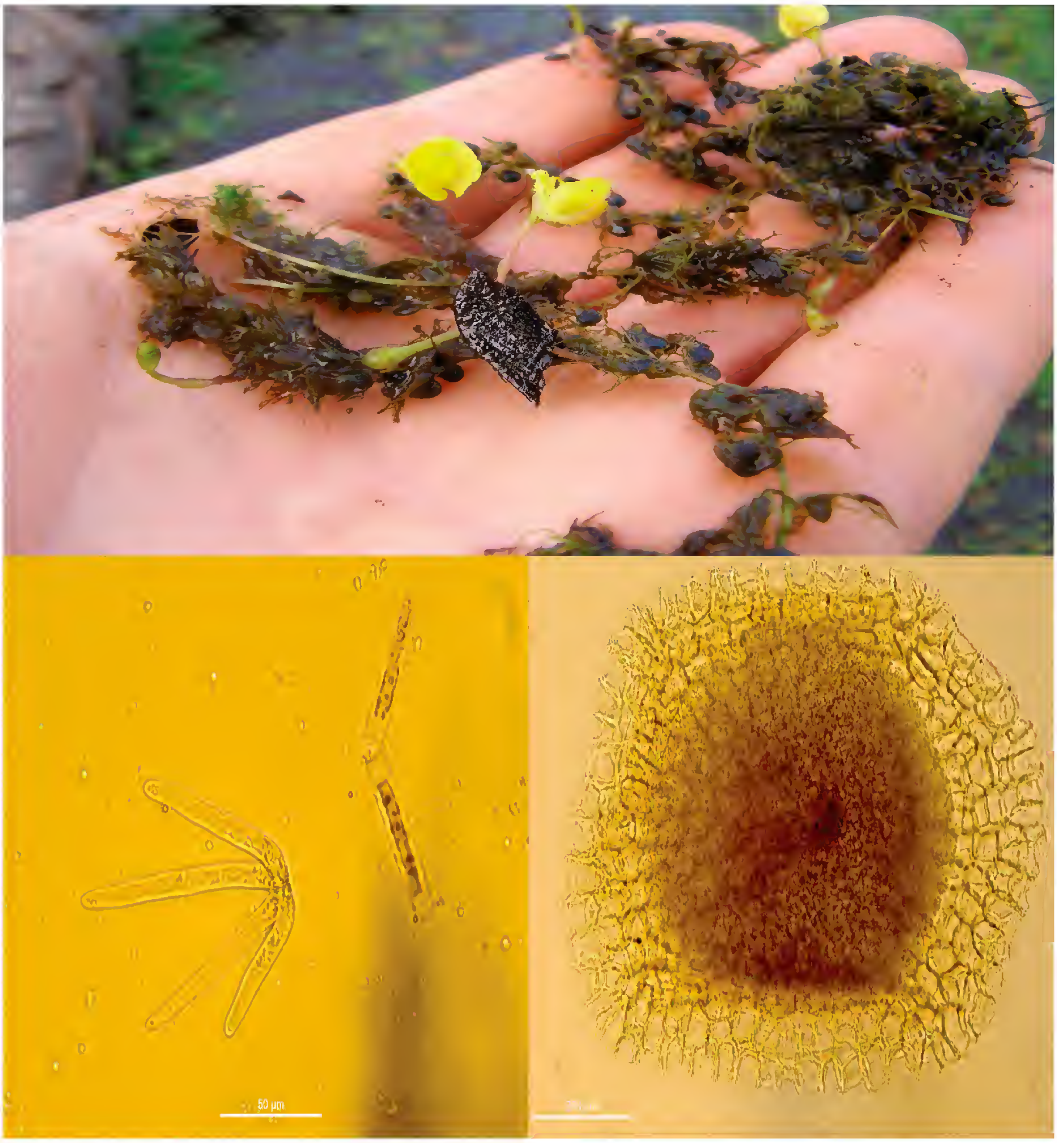

Fig. 2. ***Utricularia corneliana.*** A. habit. B. Internal quadrifid gland of bladder trap. C. flat lenticular seed. A–C from *Jobson 1281* (NSW).

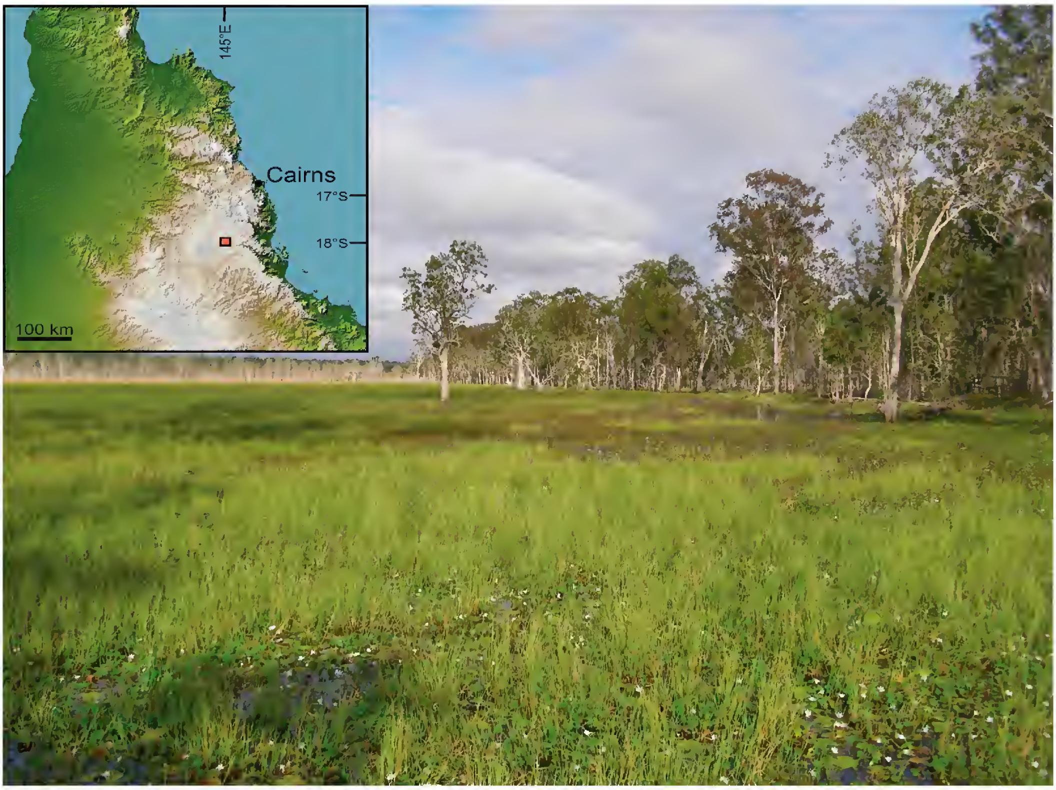

Fig. 3. Shallow swamp habitat holding the observed population of *Utricularia corneliana*. Insert is a topographic map of northern Queensland showing vicinity of collection site (red box).

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Stylidium elachophyllum A.R.Bean & M.T. Mathieson (Stylidiaceae), a new species from northern Queensland

A.R. Bean & M.T. Mathieson

Summary

Bean, A.R. & Mathieson, M.T. (2012). *Stylidium elachophyllum* A.R.Bean & M.T.Mathieson (Stylidiaceae), a new species from northern Queensland. ***Austrobaileya* 8(4): 608–612.** *Stylidium elachophyllum* is described as new. It is an ephemeral herb known only from the Hann Tableland in northern Queensland, with a morphological affinity to *S. fissilobum* F.Muell., *S. prophyllum* Lowrie & Kenneally and *S. oviflorum* A.R.Bean. The species is illustrated and diagnosed against related taxa. Its conservation status is assessed and a status of Endangered is recommended.

Key Words: Stylidiaceae, *Stylidium*, *Stylidium elachophyllum*, Australia flora, Queensland flora, new species, taxonomy, conservation status

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Introduction

The tropical triggerplants of Australia are diverse and difficult to study as they are nearly all ephemeral and are fertile just after the wet season when field access to them is difficult. A number of new *Stylidium* species from tropical Australia have been described in recent years (Lowrie & Kenneally 1997, 1999; Bean 1997, 2000, 2010).

During a visit to the Hann Tableland, west of Mareeba in north Queensland in May 2010, the second author discovered a population of *Stylidium* Sw. ex Willd. that did not match any named species. No material could be found at BRI or CNS that corresponded with this species. Further material was collected in March 2012, enabling its unnamed status to be confirmed and its formal description herein.

Materials and methods

This research is based on a study of herbarium specimens and associated spirit collection at BRI and CNS, and field studies at the type locality. All measurements have been made from material preserved in spirit.

RE refers to Regional Ecosystem, descriptions of which can be viewed at (in this case): http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/regional_ecosystems/search.php?&page=31

Taxonomy

Stylidium elachophyllum A.R.Bean & M.T.Mathieson **species nova**; affinis *Stylidio fissilobo* sed absentia glandium paracorollae, apicibus integris loborum posteriorum anteriorumque (in *S. fissilobo* utrique bilobi), labello e basi sinus anterioris affixo (in *S. fissilobo* parti externae tubi corollae affixo) et capsulis 6–9 mm longis (non 12–21 mm longis) differens. **Typus:** Queensland. Cook District: Hann Tableland National Park, NW of Mareeba, 27 March 2012, *M.T. Mathieson MTM1292* (holo: BRI [1 sheet + spirit]; iso: CNS, *distribuendi*).

Annual herb, 3–10 cm high. Glandular hairs 0.05–0.1 mm long, glands dark red to brown, globose. Rootstock not thickened. Stems present, glabrous. Leaves 2–6, scattered along stems, green, deltate, 0.5–1.7 mm long, 0.3–0.6 mm wide, sessile, glabrous, apex obtuse or acute, base truncate. Scapes absent. Inflorescences 1.5–3 cm long, determinate; branches monochasially cymose. Bracts deltate to lanceolate, 0.9–1.5 mm long, glabrous, apex obtuse or acute. Pedicels absent. Hypanthium linear, glandular-hairy at

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distal end only. Sepals elliptical, 3 free and 2 mostly fused, 1.2–1.5 mm long, 0.3–0.4 mm wide, sparsely glandular-hairy, apex obtuse. Corolla pink, tinged yellow at the junction of anterior and posterior petals, glandular-hairy on tube only. Corolla tube 1.7–2.1 mm long, with sinus on anterior side only. Paracorolla (throat appendages) discontinuous, glabrous, decurrent with corolla, free part *c.* 0.1 mm high; lobes 4–6, all similar, 2 opposite the anterior petals, 2–4 opposite the posterior petals; glands absent. Labellum attached at base of anterior sinus of corolla tube, ovate or lanceolate, 0.5–0.8 mm long, glabrous; terminal appendage absent or present, to 0.3 mm long; basal appendages absent. Corolla lobes divided to the throat, with a central longitudinal vein; anterior lobes obovate, 0.7–1.1 mm long, 0.4–0.7 mm wide, entire, obtuse; posterior lobes obovate, 1.5–1.8 mm long, 0.8–1.2 mm wide, entire, obtuse. Column 3–4 mm long, of uniform width throughout, glabrous, lateral lobes absent, spur absent. Stigma sessile. Capsule linear, without raised longitudinal ribs, 6–9 mm long excluding sepals, 0.6–0.7 mm wide, halves coherent distally. Seeds ellipsoidal, 0.2–0.25 mm long, brown, colliculate. **Fig. 1–3**.

Additional specimen examined**: Queensland.** COOK DISTRICT: Hann Tableland N.P., NW of Mareeba, May 2010, *Mathieson MTM814 & Forster* (BRI).

Distribution and habitat**:** *Stylidium elachophyllum* is endemic to northern Queensland and has been found only in the Hann Tableland N.P., about 20 km north-west of Mareeba. It grows in ephemeral vegetation in shallow soil-filled depressions or fringing mats of *Borya septentrionalis* F.Muell. on granite pavements (RE7.12.37) at approximately 800 m altitude. Vascular flora associated with this habitat at this site includes *Xyris pauciflora* Willd., *Polycarpaea spirostylis* F.Muell., *Eriocaulon pusillum* R.Br., *Drosera indica* L., *Byblis liniflora* Salisb., *Utricularia chrysantha* R.Br., *Stylidium oviflorum* A.R.Bean, *S. capillare* R.Br., annual grasses including *Schizachyrium pachyarthron* C.A.Gardner, *Dimeria ornithopoda* Trin. and *Sacciolopis indica* (L.) Chase, and annual sedges including *Fimbristylis furva* R.Br. and *Fuirena ciliaris* (L.) Roxb.. These ephemeral species grow during the wet season when there is a largely continuous supply of water, either as rain or run-off, but completely desiccate during the dry season.

Vegetation surrounding the granite pavements is comprised of sclerophyll woodland dominated by *Eucalyptus portuensis* K.D.Hill, *E. atrata* L.A.S.Johnson & K.D.Hill, *E. lockyeri* Blaxell & K.D.Hill, *Corymbia intermedia* (R.T.Baker) K.D.Hill & L.A.S.Johnson and *C. leichhardtii* (F.M.Bailey) K.D.Hill & L.A.S.Johnson, generally with scattered *Melaleuca viridiflora* Sol. ex Gaertn. and *Xanthorrhoea johnsonii* A.T.Lee in the understorey. The area is in general quite fire-prone.

Phenology**:** Flowers and fruits are recorded for March, when plants were observed to be abundant, and May, when very few plants were observed as the habitat dried out.

Affinities**:** *Stylidium elachophyllum* is morphologically allied to *S. fissilobum* F.Muell., *S. prophyllum* Lowrie & Kenneally and *S. oviflorum* of *S.* subgenus *Andersonia* (R.Br. ex G.Don) Mildbr. (see Bean 2000). It shares with these species the small scale-like leaves that are scattered along the stem of the plant, and the corolla lobes divided to the throat or almost so.

Stylidum elachophyllum differs from *S. fissilobum* by having entire corolla lobe apices (bilobed in *S. fissilobum*), a labellum which is attached at the base of the anterior sinus (attached to the outside of the corolla tube in *S. fissilobum*), and capsules which are 6–9 mm long (12–21 mm long in *S. fissilobum*). *S. elachophyllum* differs from *S. oviflorum* in possessing a pink corolla (white and yellow in *S. oviflorum*) with smaller anterior and posterior lobes, a labellum which is attached at the base of the anterior sinus (attached to the outside of the corolla tube in *S. oviflorum*), a shorter column that lacks lateral lobes, capsules which are 6–9 mm long (18–25 mm long for *S. oviflorum*), and a colliculate seed surface (smooth in *S. oviflorum*). *S. elachophyllum* differs from *S. prophyllum* in having glandular-hairy sepals (glabrous in

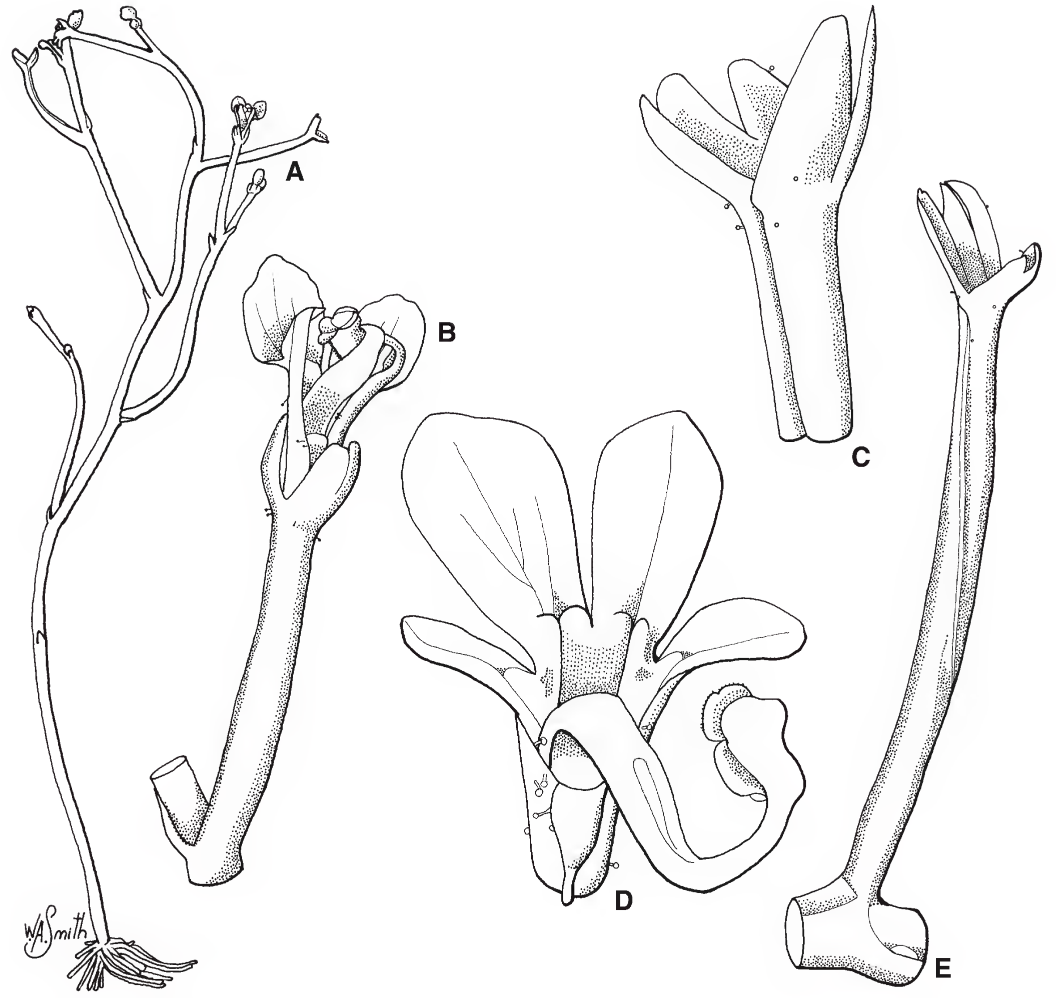

Fig. 1. ***Stylidium elachophyllum***. A. whole plant ×1.5. B. flower ×8. C. calyx lobes ×16. D. corolla and column ×16. E. undehisced capsule ×8. All from *Mathieson MTM1292* (BRI). Del. W. Smith

S. prophyllum), a smaller and more obscure paracorolla, much smaller anterior and posterior corolla lobes, a column which is 3–4 mm long (5–6 mm in *S. prophyllum*), and capsules which are 6–9 mm long (11–17 mm in *S. prophyllum*).

***Conservation status*:** This species is only known from a single location on the Hann Tableland within Hann Tableland National Park. It was not encountered elsewhere on the Hann Tableland despite extensive searches in similar habitats during two expeditions.

The population at the type locality is estimated to be between 200 and 500 plants occupying an area of less than five hectares. With encroachment of introduced, hyperinvasive grasses (*viz.* giant rat's tail grass *Sporobolus pyramidalis* (Lam.) Hitchc., grader grass *Themeda quadrivalvis* (L.) Kuntze and gamba grass *Andropogon gayanus* Kunth) and the rampant herbaceous weed *Praxelis clematidea* R.M.King & H.Rob. into the ephemeral flush wetland habitats on granite outcrops immediately adjacent to the

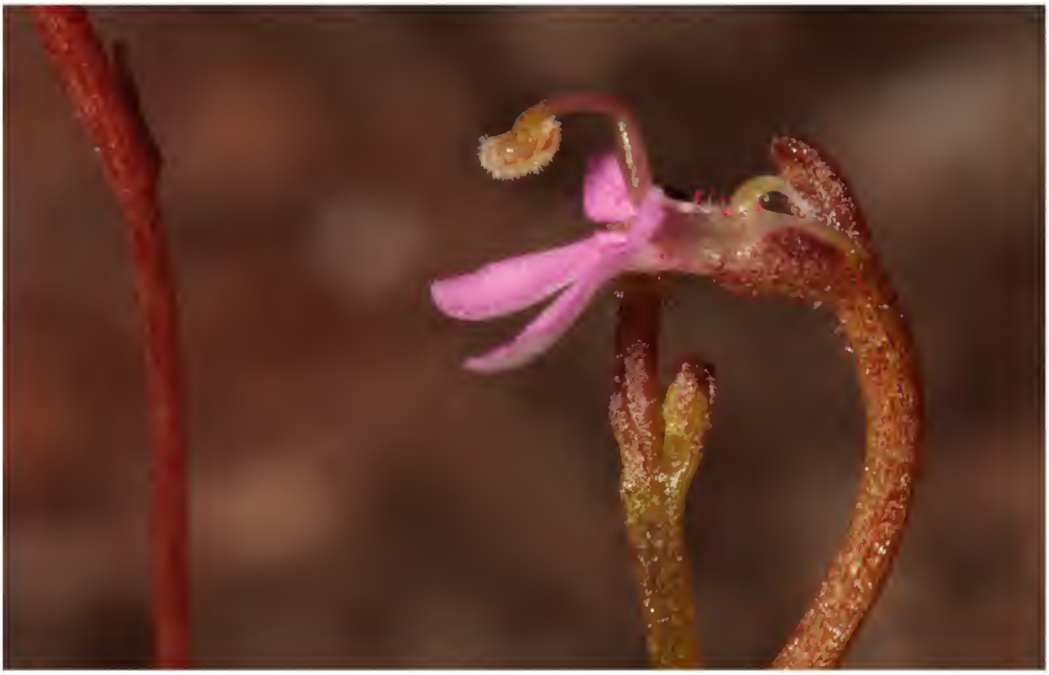

Fig. 2. ***Stylidium elachophyllum***, side view of flower, photographed in habitat (*Mathieson MTM814*)

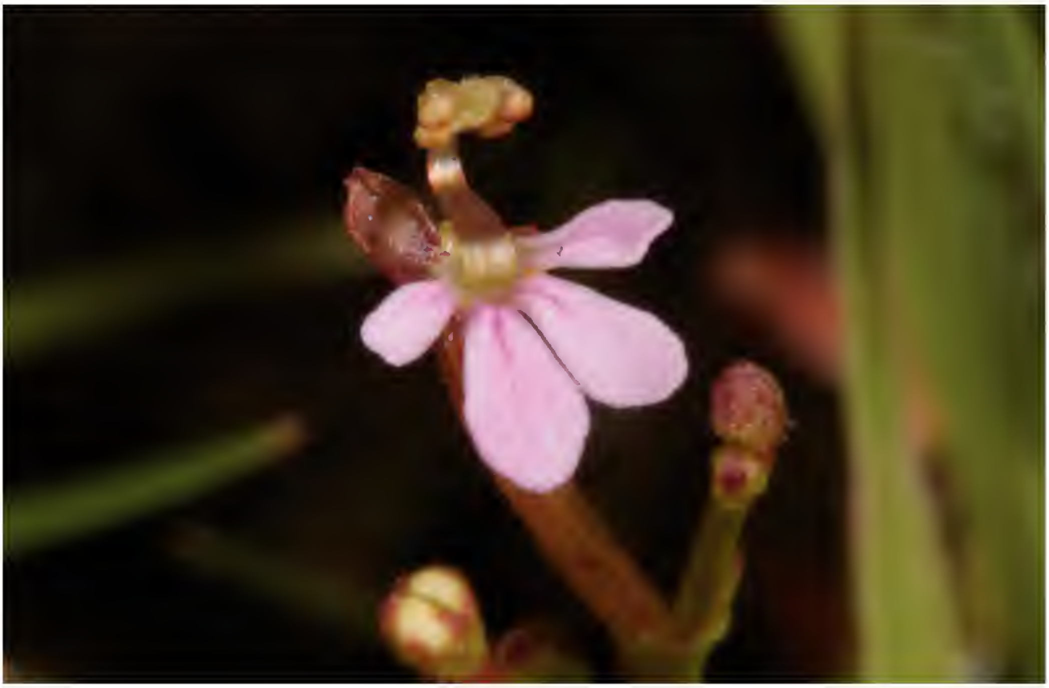

Fig. 3. ***Stylidium elachophyllum***, front view of flower, photographed in habitat (*Mathieson MTM1292*)

type locality, this population is considered greatly threatened. Applying criteria of the IUCN (IUCN 2001), the recommended conservation status is Endangered (B2b(iii); C2a(ii)).

***Etymology*:** From the Greek *elacho-* small, and *phyllon* – leaf, in reference to the very small scale-like leaves of this species.

Acknowledgements

Collections of this species were made on a Bush Blitz nature discovery expedition in 2010 and, in 2012, using a Bush Blitz Tactical Taxonomy Grant awarded to MTM; both funded by the Commonwealth Government in part. We thank Will Smith for the illustrations, and Peter Bostock for the Latin diagnosis. The following people and organisations are thanked for their assistance that made the survey possible: Keith McDonald (Dept. of Environment & Heritage Protection (DEHP)–Atherton) for logistical support and co-ordination; Traditional Owners for the Hann Tableland, John and Troy Grainer; Cairns/Mareeba National Parks & Wildlife Service staff (Jonathon Roth, Robert Miller) for logistical and field support; Cape York Tenure Unit (DEHP – Cairns) (Georgianna Fien, Eric Wason); Southedge Research Station for accommodation and use of facilities; Cape York Helicopters for safe and efficient helicopter provision.

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Austrobaileya 8(4): 613–615 (2012)

SHORT COMMUNICATION

Poikilogyne cordifolia (Cogn.) Mansf., a newly recorded genus and species of Melastomataceae for Australia

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Melastomataceae is a diverse family of plants in the order Myrtales (A.P.G. 2009). The family comprises more than 4500 species and 150 genera (Renner 1993) and exhibits its highest diversity in the Neotropics, with secondary centres of diversity occurring in the Malesian and African regions (Renner 1993; Cellinese 2007). Even though Cape York Peninsula, Queensland is relatively close to the Malesian region it harbours only five indigenous Melastomataceae species from four genera (Bostock & Holland 2010). Approximately 60% of the Australian Melastomataceae flora has been introduced by humans via the horticultural trade, including the significant environmental weeds *Clidemia hirta* (L.) D.Don, *Mikania micrantha* Kunth and *Miconia calvescens* DC. (Bostock & Holland 2010). Therefore, upon receiving an attractive and unidentified Melastomataceae collected from Cape York Peninsula it was initially expected that it belonged to a weedy horticultural species. Closer examination of the buds, leaf type, fruit type and anthers indicated that it belonged to the widespread New Guinea species *Poikilogyne cordifolia* Mansf. and that it is likely to be indigenous. It is the first record of the genus *Poikilogyne* Baker f. outside Malesia.

Poikilogyne is a genus of more than 20 species with a centre of diversity in New Guinea where there are a number of narrow range endemics (Cellinese 2007). Most *Poikilogyne* are terrestrial shrubs or vines with ovate to orbicular leaves with major veins radiating from the cordate leaf base. These veins are interconnected by cross veins which give the leaves a laddered appearance typical of many Melastomataceae. The leaf margins of many *Poikilogyne*, particularly the montane species, are toothed in some way and the indument of the leaves, buds and stems is variable with many species being scurfy or villose. The inflorescences are usually terminal and multi-branched and bear 5-merous flowers (also 4–6 merous) with 10 actinomorphic stamens and a campanulate five ribbed hypanthium (also 4–6 ribbed). The anthers are described by Cellinese (2007) as having a very small terminal pore, a prominently thickened connective and an obtuse basal spur. The fruits are dehiscent, longitudinally splitting capsules borne in a distinct 10 ribbed cup (also 8–12 ribbed) formed by the hypanthium. The fruit of *Poikilogyne* are dry and capsular and the seeds are small. This is consistent with the wind-dispersal mode for Melastomataceae rather than bird dispersal found in species with berry type fruits (Styles & Rosselli 1993).

Maxwell (1983) reduced *Poikilogyne ledermannii* Mansf. to varietal rank within *P. cordifolia* but did not provide any characters to distinguish the two varieties. Based on Mansfield's (1926) circumscription of the two taxa, and on material held in BRI that have been determined by J.F.Maxwell, I consider that the Australian specimen belongs to *Poikilogyne cordifolia* var. *cordifolia*.

Poikilogyne cordifolia (Cogn.) Mansf., *Bot. Jahrb. Syst.* 60: 111 (1926); *Allomorphia cordifolia* Cogn., *Fl. Kais. Wilh. Land [K.M. Schumann & M.U. Hollrung]* 87 (1889). **Type:**

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Papua New Guinea. *s.loc.*, in 1886, *[U.M.] Hollrung 135* (holo: B†; iso: BR 5214778, *scan*!).

Poikilogyne cordifolia var. **cordifolia**; J.F.Maxwell, *Gard. Bull. Singapore* 35: 223 (1983).

***Description of Australian specimen*:** Branching woody shrub to 1 m tall with tetrangular stems bearing a distinct keel along the corners of young and mature stems. Immature shoots with a reddish-pink blush, mature bark pale yellow-brown with a few raised corky lenticels. All parts of stems, leaves, flowers and fruits glabrous. Leaves and branchlets opposite with a distinct interpetiolar scar. Petioles fleshy, 16–110 mm long, reddish pink. Leaves orbicular-cordate, 60–160 mm long by 60–120 mm wide, with a distinctly cordate base and a weakly acuminate apex; midvein and 2–4 pairs of major lateral veins all radiating from the leaf base petiole junction and interconnected by secondary cross veins; all venation prominent on both surfaces and distinctly raised on the abaxial surface. Inflorescences terminal thyrses, 50–150 mm long and 50–150 mm wide, reddish-pink, with flowers opening sequentially. Inflorescence bracts minute, reddish-pink, sometimes absent. Flowers 5-merous, occasionally 4 or 6-merous within the same inflorescence. Pedicels 7–9 mm long and 1 mm in diameter. Hypanthium 9–14 mm long and 4–9 mm in diameter, pink, with 5 apically ribbed obtuse calyx lobes. Petals free (imbricate in bud), rounded-oval with a small keel apically, 6–9 mm long and 4–9 mm wide, bicolored, pink and white. Anthers actinomorphic, 4–6 mm long with a terminal pore and a small basal spur. Filaments 5–6 mm long at anthesis. Anthers and filaments folded inwards when flowers first open. Ovary half-inferior, truncate, style less than 5 mm long when flowers open elongating to 13 mm long and bearing a simple white to reddish-pink stigma. Inflorescences and fruit becoming dry and woody at maturity and remaining attached to the plant in branch sinuses. Fruits dry, dehiscent, loculidically splitting, capsules with sepals and hypanthium reducing to a thin partially decayed dry membrane bearing 10 persistent woody longitudinal ribs, corresponding with the mid-vein and marginal veins of the sepals, which grip the ovary. Seeds numerous per locule, less than 1 mm long, brown. **Fig 1.**

***Selected specimens examined*:** **Indonesia. Papua.** Bernhard Camp, Idenburg River, Mar 1939, *Brass 13069* (BRI). **Papua New Guinea.** Owen Stanley Range between Mts Brown & Clarence, May 1926, *Brass 1488* (BRI). **Australia. Queensland.** Cook District: Munburra, Starcke, Sep 2012, *Thompson 691* (BRI, CNS).

***Distribution and habitat*:** This species is presently known in Australia from a single record at Munburra, Starcke on eastern Cape York Peninsula where it was growing on steep metamorphic rocky slopes on an ecotone between *Eucalyptus* and *Lophostemon* dominated forest and rainforest. This species is widespread and abundant in New Guinea and it is expected that it will be more widespread in other similar, poorly accessed, habitats on eastern Cape York Peninsula.

***Notes*:** The site where *Poikilogyne cordifolia* was collected is remote, undisturbed and did not contain any introduced plant species (S.Thompson pers. comm.). This species is unknown in cultivation in Australia and it is considered unlikely that it has been introduced via the horticultural trade. Combined, these factors indicate that *Poikilogyne cordifolia* is indigenous to Australia and that it has naturally dispersed to Australia from Papua New Guinea. *Poikilogyne cordifolia* is readily distinguished from all other Australian Melastomataceae by its large orbicular-heart shaped cordate leaves and by its capsular loculidically splitting fruit which are clasped by the ribs of the sepals and hypanthium.

***Conservation status*:** Insufficient data are available to accurately assess the conservation status of *Poikilogyne cordifolia* in Australia. *Poikilogyne cordifolia* is abundant in New Guinea and could be considered secure there.

Acknowledgments

I would like to thank Simon Thompson for collecting the voucher material and also Nicoletta Cellinese and Trevor Whiffin for confirming the identification.

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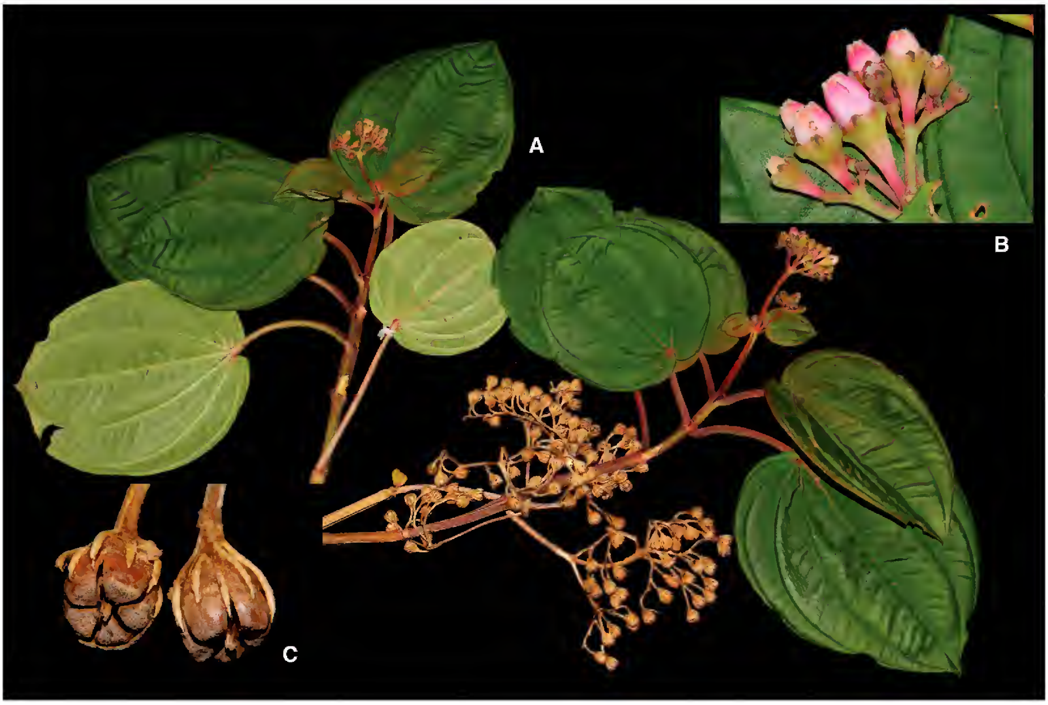

Fig. 1. ***Poikilogyne cordifolia*.** A. flowering and fruiting branch. B. lateral view of flower buds. C. lateral and apical view of mature dehiscent capsules. All from fresh material of *Thompson 691* (BRI). Photographs by Andrea Lim.

Croton lucens P.I.Forst. (Euphorbiaceae), a new species from south-east Queensland

Paul I. Forster

Summary

Forster, P.I. (2012). *Croton lucens* P.I.Forst. (Euphorbiaceae), a new species from south-east Queensland. ***Austrobaileya* 8(4): 616–623.** A shrubby, perennial species of *Croton* L. from the Gympie area in south-east Queensland is newly described as *Croton lucens* P.I.Forst. This new species is known from only three small populations (less than 100 plants) and is considered Endangered. An identification key is provided for *Croton* species from south-east Queensland that have foliage that is penninerved and fawn-silver to silver-white below.

Key Words: Euphorbiaceae, *Croton*, *Croton lucens*, Australia flora, Queensland flora, identification key, taxonomy, new species, endangered conservation status

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Introduction

A revision of Australian *Croton* L. was published ten years ago with twenty-seven native species recognised (Forster 2003). An additional native species (*C. dichromifolius* P.I.Forst.) from Cape York Peninsula was added by Forster (2010).

Fieldwork near Gympie, south-east Queensland in July 2009 resulted in the discovery of several populations of what appeared to be a previously unknown and undescribed species of *Croton*; however, this material was sterile and no collections were made at the time. Subsequent revisits to the three known localities have resulted in several collections of fertile material and it is now possible to describe these in the current paper as the new species *Croton lucens* P.I.Forst.

Under the schema of Forster (2003), this species can be placed in **Group 5**, along with *Croton capitis-york* Airy Shaw, *C. dichromifolius*, *C. insularis* Baill., *C. mamillatus* P.I.Forst., *C. phebalioides* Muell. Arg., *C. simulans* P.I.Forst. and *C. stigmatosus* F.Muell. This group of species comprises all shrubs or small trees with penninerved foliage that is ± silver-white below due to dense adpressed indumentum of trichomes and/or scales. Unpublished molecular analysis of Australian *Croton* indicates that these species (with *C. stockeri* Airy Shaw added) may be a relatively natural grouping (P. Berry & B. van Ee pers. comm. Feb 2010), although *C. lucens* remains to be sequenced and compared to these species. An identification key is provided for the south-east Queensland representatives of this group of Crotons.

Materials and methods

Data presented and discussed in this paper are based on field collections and observations made between 2009 and 2012 with specimens deposited in the Queensland Herbarium and duplicate distribution as indicated. The morphological description (especially indumentum types) is modelled on those of Forster (2003). Venation terminology largely follows Hickey (1973) and Ash *et al.* (1999) with the recognition of a midrib (1° vein order), lateral veins (2° vein order) and intercostal veins (3° and onwards vein orders) within any leaf lamina. When an intercostal vein comprises a continuous raised line of cells it is termed 'distinct'; if it is discontinuous or fades away into the body of the lamina, it is termed 'indistinct'. Indumentum cover is described using the terminology of Hewson (1988), except that 'scattered' is used instead of 'isolated'. The shapes of leaves, sepals and

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petals are described using the terminology of Hickey & King (2000). Length and width dimensions are indicated as length measurement × width measurement followed by the measurement unit.

Abbreviations used in text: *NCA* (*Nature Conservation Act 1992*) http://www.legislation.qld.gov.au/legisltn/current/n/naturecona92.pdf

Taxonomy

Croton lucens P.I.Forst., **species nova**; *C. insulari* Baill. simillimus sed ab eo nectariis extrafloralibus absentibus vel tubulosis (non sessilibus circularibusque), lamina folii idioblastis densis reflectivis in pagina superiore praedita (adversum apparenter nullam) et floribus masculis minoribus staminibus paucioribus (10 vel 11 non 14–18) differt. **Typus:** Queensland. Wide Bay District: Marys Creek State Forest (S.F.124), Groundwater Logging Area, Spring Gully; 18 km SW of Gympie, 10 February 2012, *P.I. Forster PIF38604* (holo: BRI [2 sheets + spirit]; iso: MEL, MICH).

Perennial shrub or small tree to 5 m tall, evergreen, monoecious; indumentum primarily of sessile peltate scales, uncoloured to pale silver to silver-yellow or silver-brown (with age) (appearing fawn-silver to silver *en masse*), peltate scales silver-yellow to silver-brown in central column and uncoloured to pale silver-brown in the rays, other trichomes uncoloured. Bark flaky in irregular patches, cream-fawn. Branchlets ± rounded, with dense interlocking peltate scales when young and on most leafy stems, glabrescent; stipules subulate, entire, 6–8 × 0.4–0.5 mm, with dense peltate scales coloured brown-fawn. Leaves alternate, thinly coriaceous, markedly discolorous, petiolate; petioles 3.5–5.5 × 1–1.2 mm, deeply channelled on top, with dense interlocking peltate scales; lamina elliptic-ovate to obovate, 13–75 × 4–26 mm, penninerved with 5–7 lateral 2° veins per side of 1° midrib; upper surface glossy, dark green, 1° and 2° veins barely visible, 3° veins obscure, sparse and often deeply embedded peltate scales over entire surface, dense reflective idioblasts; lower surface fawn-silver, 1° veins raised, 2° veins scarcely visible and indistinct, 3° veins obscure, surface completely obscured by dense, interlocking peltate scales, neither scabrid nor velutinous; margins slightly undulate, not toothed; foliar glands absent; tip acute to acuminate, base cuneate; extrafloral nectaries apparently absent on most leaves, occasionally present and tubular to *c.* 0.8 × 0.2 mm, *c.* 3 mm from lamina base. Inflorescence short, up to 14 mm long, unbranched, usually bisexual and androgynous, mixed glomerules not observed, pedunculate for 1–1.5 mm, axis with dense, interlocking peltate scales; bracts lanceolate-ovate, much reduced, 0.2–0.3 × 0.1–0.2 mm with dense peltate scales (no trichomes). Male flowers *c.* 5 mm long and 4 mm diameter (includes pedicels), singly or two open per inflorescence, generally not in glomerules and spirally spaced 0.2–0.3 mm apart; pedicels *c.* 1.5 × 0.2 mm, with dense peltate scales; sepals valvate, lanceolate-ovate, 1.4–1.5 × 1–1.2 mm, with dense peltate scales coloured silver-brown; petals lanceolate to weakly oblanceolate, 1.2–1.4 × 0.7–0.8 mm, densely marginally ciliate and with a dense tuft of interlocking peltate scales in apical 1/3; stamens 10 or 11, with dense simple trichomes at base, filaments filiform, 3–3.5 × 0.1–0.2 mm, glabrous, anthers oblong-ovoid, 0.7–0.8 × 0.5–0.6 mm, cream, glabrous. Female flowers held singly and spaced up to 1 mm apart on inflorescence axis; pedicels *c.* 6 × 1 mm (up to 9 mm long in fruit), with dense, interlocking peltate scales; sepals valvate, lanceolate-ovate, 1.3–1.5 × *c.* 1 mm, with dense marginal cilia and dense peltate scales externally; petals absent; styles 3, linear-flabellate to 2 mm long, multifid and once divided for 1.1–1.8 mm, barely connate at base, with dense peltate scales to above the point of division, occasional minute simple glandular trichomes on tips; ovary 3-locular, *c.* 3 × 3 mm, with dense interlocking peltate scales. Fruits trilobate, globose-ovoid, 7–8 × 7–8 mm, with dense interlocking peltate scales. Seeds ovoid, 3.5–6 mm long, 2.8–4 mm wide, 1.5–1.7 mm thick, pale brown with occasionally dark brown blotches, ventral surface bifacial, dorsal surface rounded,

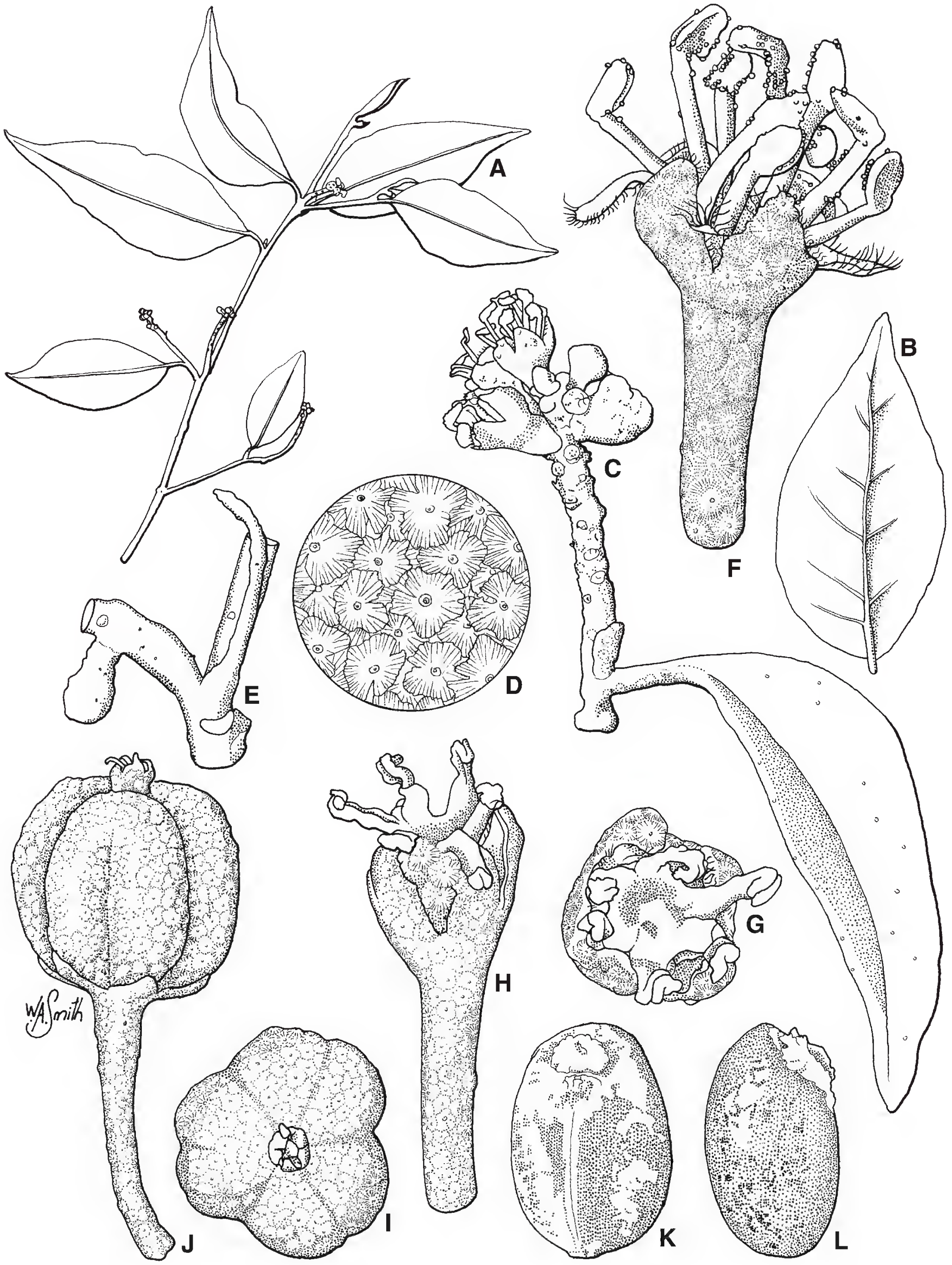

Fig. 1. ***Croton lucens***. A. habit of fertile branchlet ×0.6. B. leaf abaxial surface showing 1° midrib and 2° lateral venation ×1. C. node with single inflorescence and ♂ flowers ×4. D. dense interlocking peltate scales present on most vegetative parts ×24. E. node with stipule ×4. F. lateral view of ♂ flower ×12. G. apical view of ♀ flower ×12. H. lateral view of ♀ flower ×8. I. apical view of fruit ×4. J. lateral view of fruit ×4. K. ventral view of seed ×6. L. lateral view of seed ×6. A–F from *Forster PIF38604* (BRI); G & H from *Leiper s.n.*, Jun 2012 (BRI); I–L from *Leiper s.n.*, Jan 2012 (BRI). Del. W.Smith.

micropylar ridge 2.8–4.8 mm long, caruncle broadly depressed-ovate, 0.6–1 mm long, 0.8–1.2 mm wide, cream. **Figs. 1–4.**

Additional specimens examined. **Queensland.** WIDE BAY DISTRICT: Marys Creek State Forest (S.F. 124), near Marys Creek Bridge; 13 km WSW of Gympie, Jan 2012, *Leiper s.n.* (BRI, MEL); *ditto loc.*, Feb 2012, *Leiper & Smyrell s.n.* (BRI, NSW); *ditto loc.*, Jun 2012, *Leiper s.n.* (BRI).

***Distribution and habitat*:** *Croton lucens* has so far been found only in Marys Creek State Forest to the southwest of Gympie in south-east Queensland. Plants grow in the understorey of hoop-pine vineforest (araucarian microphyll vineforest) on shallow, stony, red soils that are derived from a complex mixture of metasediments and volcanic intrusions. The geology of this area is highly complex and comprises substrates that have been intermixed and altered by subsequent volcanic activity via vents and limited scale flows (Ostwald 1992; Sivell & McCullock 2001; Sivell & Waterhouse 1998). The red colour of the soils at the localities of the three known populations may be due to weathering of andesite (or less likely basalt or granite) intrusions; however, limited observation of outcropping rocks indicated a predominance of more ancient Permian metasediments.

***Notes*:** *Croton lucens* has markedly discolorous foliage, although this in itself is a common character in the genus. The dense, interlocking peltate scales impart a fawn-silver appearance to the lower surface of the leaf lamina, although on close examination with magnification the scales appear silver-yellow to silver-brown in the central column and uncoloured to pale silver-brown in the rays. While many Crotons have this sort of foliage, *C. lucens* is notable for the 'shimmering' appearance of the foliage, which seems to be a result of light reflection from the numerous embedded idioblasts on the abaxial surface of the leaf lamina (**Fig. 2**).

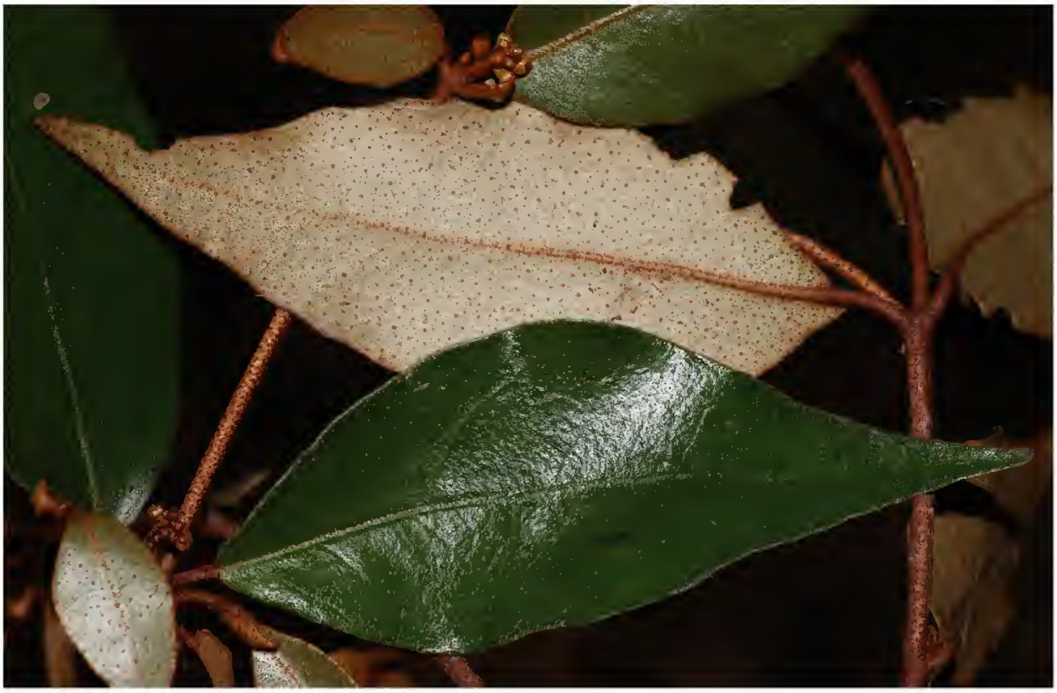

Fig. 2. ***Croton lucens.*** Foliage showing glossy, reflective adaxial surface and silver-white abaxial surface (from *Leiper & Smyrell s.n.* [BRI]). Photo: G.Leiper.

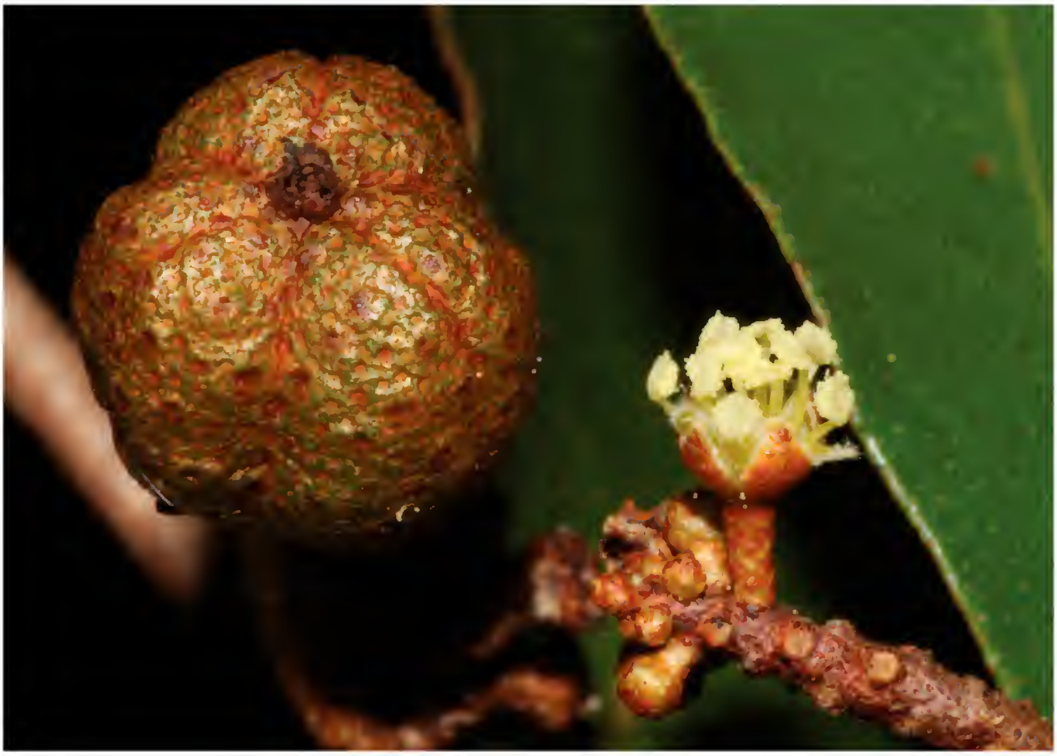

Fig. 3. ***Croton lucens***. Fruit and male flower (from *Leiper & Smyrell s.n.* [BRI]). Photo: G.Leiper.

In some respects, the general habit of *Croton lucens* is most similar to *C.mamillatus;* however, the newly described species differs from the latter in numerous character states of foliage, flowers and fruit (**Table 1**). In terms of the foliage indumentum, *C. lucens* is most similar to *C. insularis*; however it differs from this species in the extrafloral nectaries (absent or tubular versus sessile and circular), the leaf lamina with dense reflective idioblasts above (versus apparently none) and the smaller male flowers with fewer stamens (10 or 11 versus 14–18). The inflorescences of *C. lucens* (**Figs. 3 & 4**) are consistently much shorter (up to 14 mm long) than those of *C. insularis* (up to 120 mm long [Forster 2003]) and as a result have far fewer flowers per individual unit. Under some drought conditions the latter species may also have relatively short inflorescences (less than 50 mm long); however, these are usually intermixed on the same individual with longer, more typical ones. Despite the sympatry between these two superficially similar species, no intermediates have been observed.

Very little fertile material was available for description of this species and the degree of variation in floral part numbers and sizes may be more than documented here. Collectors should pay particular attention to locating female flowers as these have been rarely encountered and are more inconspicuous when compared to the males.

Conservation status: *Croton lucens* is infrequent at Marys Creek State Forest with only three small populations (less than 100 plants observed) known; all are highly localised and two are in close proximity (less than 1 km apart). It is likely that the three populations are merely subpopulations of a single metapopulation.

This State Forest has been largely altered by conversion of the natural forest to hoop-pine (*Araucaria cunninghamii* Aiton ex A.Cunn.) plantations; most now on a second

Table 1. Comparison of morphological character states for some south-east Queensland species of *Croton*

Character state	***C. insularis***	***C. lucens***	***C. mamillatus***	***C. phebaliodes***	***C. stigmatosus***
Branchlet indumentum	dense, interlocking peltate scales	dense, interlocking peltate scales	dense peltate trichomes	dense stellate trichomes	dense peltate scales and scattered stellate trichomes
Extrafloral nectaries on leaf	usually 2 at top of petiole, sessile, circular	general absent, or tubular and near lamina base	generally absent, or sessile circular	usually 2 at lamina base, sessile, ellipsoid	usually 2 at lamina base, stipitate and circular
Leaf lamina margin	entire or somewhat sinuate	somewhat sinuate	± entire or weakly denticulate	entire, sinuate or denticulate with 11–18 teeth	denticulate with 14–24 teeth
Leaf lamina 2^{o} lateral veins	5–8, ± obscure due to indumentum	5–7	12–14	7–14	12–15
Leaf lamina adaxial surface indumentum cover	dense, interlocking peltate scales	dense, interlocking peltate scales	dense peltate trichomes and peltate scales	dense, interlocking peltate trichomes	dense stellate trichomes and dense peltate scales
Male flower pedicel length	2.3–5 mm	*c.* 1.5 mm	2.5–3 mm	1.5–3.5 mm	2–4 mm
Male flower sepal shape and size	lanceolate-triangular, 1.5–2.5 × 1.2–1.6 mm	lanceolate-ovate, 1.4–1.5 × 1–1.2 mm	lanceolate-ovate to ovate, 1.8–2.2 × 1.4–1.5 mm	lanceolate-ovate to obovate, 1.2–2.7 × 1.3–1.8 mm	lanceolate-ovate, ovate or obovate, 1.5–2.2 × 0.4–1.4 mm
Male flower petal shape and size	oblanceolate, 1.7–2.6 × 0.6–1 mm	lanceolate to weakly oblanceolate, 1.2–1.4 × 0.7–0.8 mm	obovate, 1.5–2 × 0.6–0.7 mm	obovate, 1.3–3 × 0.5–0.7 mm	obovate, 1.5–2.2 × 0.3–8 mm
Style division	once	once	twice	twice	twice
Stamen number	14–18	10 or 11	9 or 10	10–12	10–12
Fruit surface indumentum and protuberances	dense interlocking peltate scales, no mamillate protuberances	dense interlocking peltate scales, no mamillate protuberances	dense stellate trichomes on fleshy mamillate protuberances	dense, sessile and stalked stellate trichomes	dense, stalked trichomes on fleshy mamillate protuberances

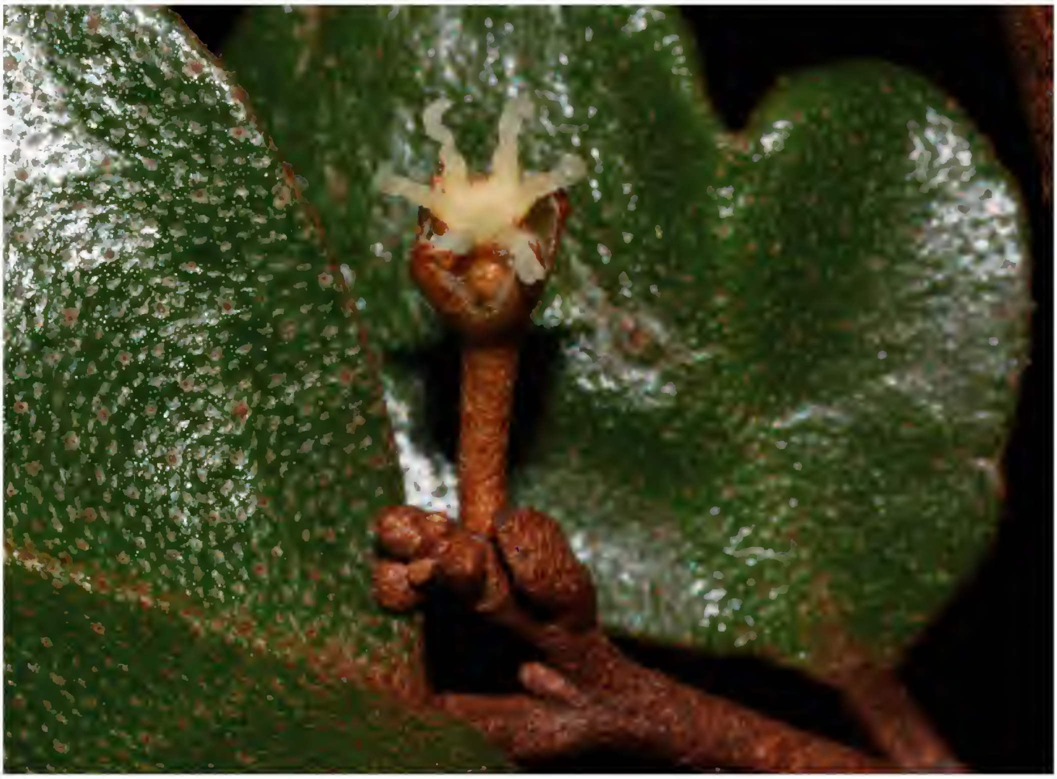

Fig. 4. ***Croton lucens*****.** Female flower (from *Leiper s.n.*, Jun 2012 [BRI]). Photo: G.Leiper.

rotation. The vineforest community now exists mainly as small patches or narrow strips (forest breaks) alongside watercourses or on very steep slopes. The degree of habitat fragmentation due to this historical forest conversion is very high and connectivity between many of the fragments is likely to be minimal for plant species that are not particularly vagile via vertebrate or wind dispersal.

Compounding the habitat fragmentation are severe and extensive infestations of numerous alien environmental weeds, including *Aristolochia elegans* Mast, *Asparagus africanus* Lam., *Dolichandra unguis-cati* (L.) L.Lohmann, *Lantana camara* L. and *Solanum mauritianum* Scop. These weeds are present not only in the areas of forestry plantation, but are also widespread within the canopy of the vineforest remnants where no attempts at control are presently being made.

Populations of several threatened plant species listed under the *NCA* such as *Cupaniopsis shirleyana* (F.M.Bailey) Radlk., *Floydia praealta* (F.M.Bailey) LA.S.Johnson & B.G.Briggs, *Fontainea venosa* Jessup & Guymer and *Macadamia integrifolia* Maiden & Betch co-exist with *Croton lucens*; hence in an ideal world the known localities for this new species would be co-managed with the others.

Under the *IUCN* (2001) criteria, this species can be assessed as **Endangered** on the criterion **D**.

Etymology**:** The specific epithet is derived from the Latin *lucens* (shining, polished, glistening) and alludes to the strikingly discolorous foliage that appears to shimmer in a light breeze.

Key to *Croton* species with penninerved and markedly discolorous foliage (± silver-white or fawn-silver below) in south-east Queensland

1 Branchlet indumentum and leaf lamina adaxial surface indumentum comprising only dense interlocking peltate scales **2**

1. Branchlet indumentum and leaf lamina adaxial surface indumentum of dense peltate or stellate trichomes, or a mixture of peltate scales and peltate or stellate trichomes. **3**

2 Extrafloral nectaries 2 at top of petiole, sessile and circular; male flower pedicel length 2.3–5 mm, stamens 14–18 . . . . **C. insularis**

2. Extrafloral nectaries absent, or 2 near lamina base and tubular; male flower pedicel length <2 mm, stamens 10 or 11 . . . . **C. lucens**

3 Branchlet indumentum of dense peltate trichomes; fruit surface with dense stellate trichomes on fleshy mamillate protuberances. . . . . **C. mamillatus**

3. Branchlet indumentum of dense stellate trichomes, or dense peltate scales and scattered stellate trichomes; fruit surface with dense, sessile and stalked stellate trichomes or with dense, stalked trichomes on fleshy mamillate protuberances **4**

4 Branchlet indumentum of dense stellate trichomes only; extrafloral nectaries usually 2 at lamina base, sessile, ellipsoid; leaf lamina adaxial surface indumentum of dense, overlapping peltate trichomes . . . . **C. phebalioides**

4. Branchlet indumentum of dense peltate scales and scattered stellate trichomes; extrafloral nectaries usually 2 at lamina base, stipitate and circular; leaf lamina adaxial surface indumentum of dense stellate trichomes and dense peltate scales . . . . **C. stigmatosus**

Acknowledgements

Repeated visits in pursuit of fertile material to two of the localities for this species were undertaken by Glenn Leiper and Greg Smyrell. Will Smith drew the illustrations and Peter Bostock provided the Latin diagnosis.

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Capsule Dehiscence in *Viola betonicifolia* Sm. (Violaceae)

R. John Little[1] & Glenn Leiper[2]

Summary

Little, J. & Leiper, G. (2012). Capsule dehiscence in *Viola betonicifolia* Sm. (Violaceae). ***Austrobaileya* 8(4): 624–633**. Seed dispersal syndromes in *Viola* are reviewed and the sequence of events culminating in the dispersal of seeds from capsules of *Viola betonicifolia* is documented. Seed parameters (length × width) and measurements of distances travelled after being ballistically ejected from a capsule valve were determined. Preliminary observations were recorded of the approximate length of time for a mature capsule to open and the approximate time for an open capsule to eject all seeds from its three valves.

Key Words: Violaceae, *Viola*, *Viola betonicifolia*, capsule dehiscence, diplochory, myrmecochory

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Introduction

The effective dispersal of seeds to sites where seedlings can successfully establish is critical to most vascular plants that reproduce sexually (Forster 2007). Understanding the methods by which seeds are dispersed provides valuable information about a species' potential for distribution and colonisation, and potential taxonomic relationships. Two distinct seed dispersal syndromes have been recognised in *Viola*: 1. **myrmecochory** (seed dispersal by ants following passive release from capsules) and 2. **diplochory** (explosive ejection of seeds followed by attraction and dispersal by ants) (Beattie & Lyons 1975). Characters attributable to the myrmecochory syndrome include a prostrate peduncle during dehiscence with the capsule on or near the ground; a calyx often swollen during fruiting; a capsule with walls not greatly thickened; seeds never under pressure during dehiscence; seeds with a large and conspicuous elaiosome; and seeds that are dispersed passively beneath the parent plant. Characters attributable to the **diplochory** syndrome include a tall peduncle that is erect during dehiscence and carries the capsule above the leaves; a calyx that does not enlarge during fruit development; a capsule with walls thickened with sclereids that produce pressure on seeds; seeds with a small elaiosome; and seeds that are ballistically dispersed 1–5 m from the parent plant. A third type, called ballistic or **autochory** (explosive ejection of seeds away from the parent plant not related to ant dispersal) has been suggested for *Viola*, but was not detected as a distinct syndrome in the species studied by Beattie & Lyons (1975).

Perhaps the first documented observation of capsule dehiscence in *Viola* was that of Leavitt (1902) for *Viola rotundifolia* Michx., a perennial species from North America. Based on the distance that seedlings germinated in his garden from a single 'mother' plant, the species appeared able to ballistically eject its seeds 1.5–2.7 m (Leavitt 1902). Harrington (1903) stated, "after dehiscence [the capsule valves] fold lengthwise and eject the seeds with some force," and Bare (1979) said, "As each segment dries, it slowly folds together lengthwise, and the resultant pressure on the seeds throws them several feet through the air."

The method by which the capsules of diplochorous *Viola* species dehisce has been described variously as "sometimes dehiscing explosively" (Lawrence 1951),

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"the matured capsule opens and ejects the seeds in a moment" (Ohkawara & Higashi 1994), "seeds are explosively ejected from the capsules" (Douglas & Ryan 1998), "opening ± explosively on maturity" (Thiele & Prober 2003), and "at maturity the capsule springs open and the seeds are forcefully ejected" (Karlsson *et al.* 2012). These descriptions give the impression capsules 'explode' to release their seeds, in a manner similar to some genera in the *Euphorbieae* (Forster 2007). These descriptions obscure the actual mechanism by which capsules of many *Viola* species open and how the seeds are subsequently dispersed. Other workers describe how seeds are released from the capsule, e.g., "explosively ejected", "ballistically dispersed", or "ballistically ejected", which more accurately describes how seeds are dispersed (Turnbull & Culver 1983; Bulow-Olsen 1984; Brooks & McGregor 1986; Douglas & Ryan 1998; Little & McKinney in prep). However, there appear to be no detailed studies for diplochorous species documenting the actual process by which *Viola* capsules open and how the seeds are dispersed.

This note focuses on *Viola betonicifolia* Sm. subsp. *betonicifolia*, a species native to Australia. This species possesses characters attributable to the diplochorous seed dispersal syndrome, i.e., a tall peduncle with the capsule above the leaves at the time of dehiscence, a calyx that does not enlarge when the capsule develops, seeds with a small elaiosome, and seeds that are ballistically ejected some distance from the parent plant.

During a visit by the first author to Queensland and New South Wales, Australia, from November 2011 through January 2012, an opportunity arose to observe mature capsules of *Viola betonicifolia* and *V. hederacea* Labill. splitting open and to observe how seeds were ejected from capsules of *V. betonicifolia*. The second author made numerous additional observations in 2012 of how capsules open in *V. betonicifolia* and documented distances that seeds were ejected.

Questions we attempted to answer in this study for *Viola betonicifolia* included:

- What is the sequence of events for the peduncle and capsule leading up to seed dispersal?
- Does the inverted peduncle of cleistogamous capsules remain pendant or become erect?
- How long does it take for a mature capsule to open?
- How long before seeds begin to disperse from an open capsule?
- Are seeds dispersed randomly from a valve, or is there a pattern (e.g., do seeds disperse first from the center, the proximal, or the distal ends of a valve)?
- What are minimum and maximum dispersal distances?

For comparison with other *Viola* species we documented the number of seeds produced by cleistogamous flowers (abbreviated CL, which are self-pollinated flowers, with minute or no petals); measurements of seed lengths; and morphological details of chasmogamous flowers (abbreviated CH, which are flowers with showy petals).

Materials and methods

There were two rounds of observations. The first author observed and photographed *Viola betonicifolia* plants near Mt Lindesay in south-eastern Queensland, in December 2011 and 20 January 2012 during visits with the second author. Initial observations of capsules opening and seeds being ballistically ejected were made by the first author on 22 January 2012 from a plant collected as a voucher specimen on 20 January 2012, but not yet pressed. In the field, the collected plant was placed in a cup of water. The plant had two capsules which for convenience are discussed herein as A and B. Capsule A was photographed at different intervals after it had opened until all seeds were ejected. The number of seeds in each valve was determined for Capsule A, as was the approximate length of time from when it began to open until all seeds were ejected. While attention was focused on Capsule A, Capsule B had opened and ejected an unknown number of seeds.

Observation of Capsule B began when it had a total of 10 seeds remaining among the three valves. For both capsules, the time of day and number of seeds remaining in each valve were recorded at periodic intervals and documented with photographs.

Although valuable data were obtained during this first period of observation by the first author, dispersal distances could only be roughly approximated due the fact that it was difficult to observe where the dehisced seeds had landed. Dr Paul Forster encouraged the authors to gather better data on dispersal distances. The second author volunteered to continue a second round of observations and to measure dispersal distances and seed parameters. Eventually, container-grown plants were obtained and maintained outdoors by the second author in Beenleigh, Queensland. During this study, no CH flowers were present. Plants with CL capsules that appeared ready to open were brought indoors and dispersal distances were able to be measured under controlled circumstances. To determine dispersal distances, white flannelette sheets with roughened surfaces to minimize bounce of seeds were placed around the containers and the distances where seeds landed were measured by two observers.

Photographs were taken of maturing capsules to document

a) the movement of the peduncle;
b) the position of capsules prior to splitting and opening;
c) whether capsules open slowly or explosively;
d) the number of seeds per capsule; and
e) if seeds are randomly dispersed from a valve or if there is a pattern by which they are dispersed.

Seed measurements (length × width) were made by the second author with a micrometer. Statistics were calculated with Microsoft® Excel.

Results

Viola betonicifolia subsp. *betonicifolia* is a perennial, acaulescent species native to the east coast of Australia from South Australia and Tasmania to Queensland; it is also found in New Guinea and the Philippines. It occurs in a wide range of habitats from coastal dunes and sclerophyllous forest to alpine herbfields (Adams 1982). The species produces both CH and CL flowers. The species is available for horticulture commercially and is sold in Australia mainly through specialist native plant nurseries.

Floral Morphology

Fig. 1 is a typical CH flower of *Viola betonicifolia*. The lateral petals are bearded (Adams 1982; James 1990a,b). We found that CH flowers on some plants at Mt Lindesay also have hairs on the two upper petals (**Fig. 1**), which has not previously been reported. The CL flowers of *V. betonicifolia* have sepals but no petals (**Fig. 2**).

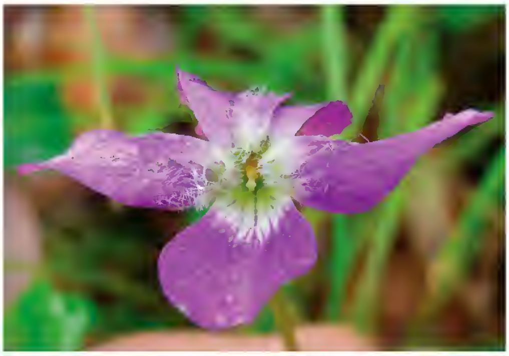

Fig. 1. Typical CH *Viola betonicifolia* flower; Mt Lindesay, Queensland. Photo: J. Little

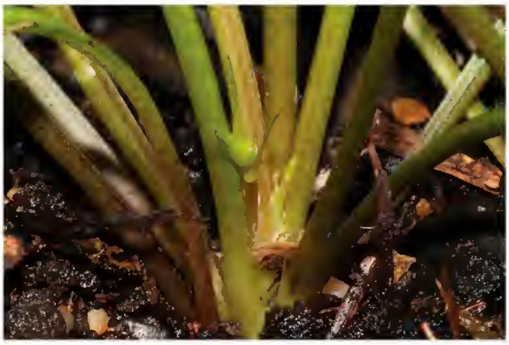

Fig. 2. A CL flower developing from the base of the plant. Sepals are visible enclosing the ovary. Petals are absent. Photo: G. Leiper

Capsules

After the ovules are fertilized, the capsules of CL flowers begin maturing in an inverted position, typical of CL flowers of many *Viola* species. As the capsule matures the peduncle elongates, lifting the capsule to an elevated position above many of the leaves. It transitions from an inverted to an upright position in about 24 hours (**Fig. 3**). The capsule also becomes noticeably paler, possibly because the xylem ceases functioning. The capsule becomes dehydrated to facilitate splitting open and eventual seed dispersal. The number of fertile seeds can be counted when the capsule is upright. In about another 24 hours, the capsule begins to split open (**Fig. 4**), the three valves begin to spread back and become completely separated (**Fig. 5**). Eventually the valves become more or less parallel to the ground (**Fig. 6**). Occasionally, a few seeds are ejected before the capsule is fully open.

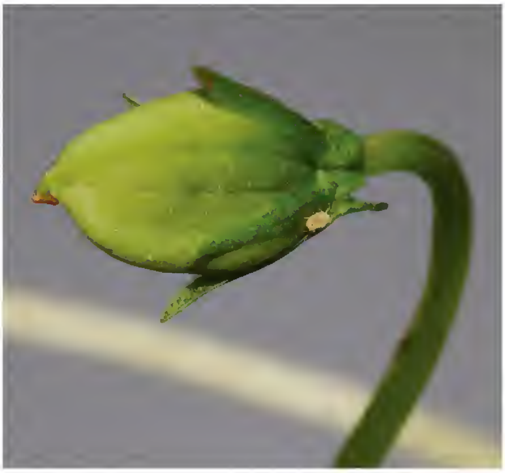

Fig. 3. Capsule from CL flower on peduncle transitioning from inverted to upright position. Photo: G. Leiper

As the capsule valves begin to dry, the edges move toward each other. The pressure of the constricting valves squeezes the seeds which eventually causes them to be ballistically ejected. We observed that seeds at the distal end of valves were ejected first (**Fig. 6**) and those at the proximal end were ejected last (**Fig. 7**). However, for other capsules

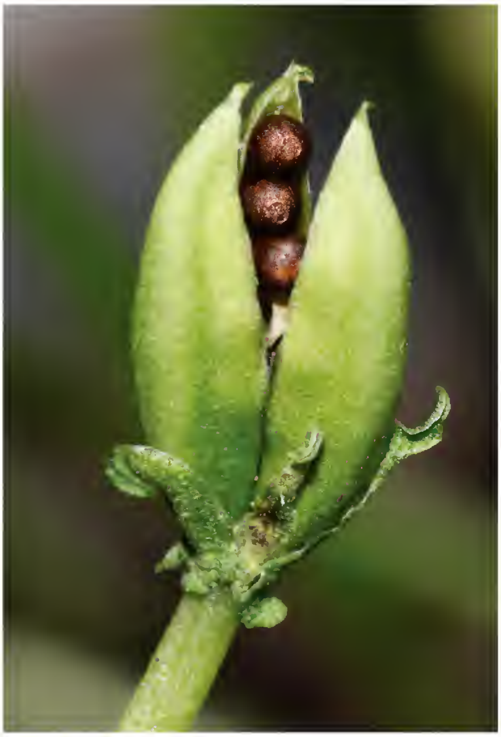

Fig. 4. Capsule in fully upright position beginning to split open. Note shrivelled sepals. Photo: G. Leiper

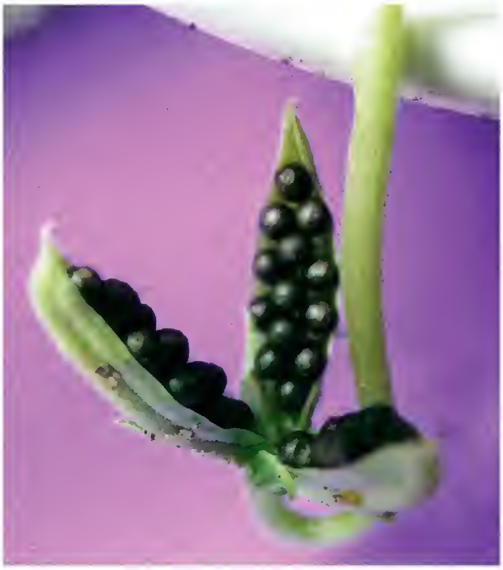

Fig. 5. Capsule completely split open with valves beginning to spread apart. Each valve is ca. 13 mm long. Photo: J. Little

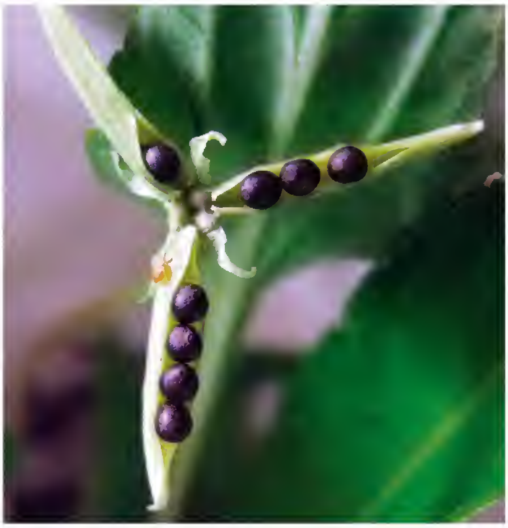

Fig. 6. Seeds in a valve about midway through dehiscence. Note the distal end of these valves contracted before the proximal end. Photo: J. Little

seeds at the proximal end were ejected first. Most capsules observed in this study (n=7) ejected all their seeds (**Fig. 8**).

Observations of Seed Dehiscence

Capsule A (recorded by first author): Capsule A was first observed open and in an upright position at 1121 with a total of 35 seeds (**Table 1**). The length of time it took to transition from an inverted to upright position was not observed nor was the time noted when the first seed was ejected. All seeds were ejected from the capsule in about 2.3 hr (138 minutes). Valve 1, which initially had two more seeds than the other valves, retained its seeds for a longer period of time. Valve 3 was the first to eject all its seeds.

Capsule B (recorded by first author): This capsule was first noticed when it was open and after it had ejected an unknown number of seeds. Observations of Capsule B began at 1603 when it had 10 seeds remaining (**Table 2**). Nine seeds were dispersed in the next 23 minutes. The time when the last seed was ejected from Valve 3 was not observed, but no seeds were present at 1715.

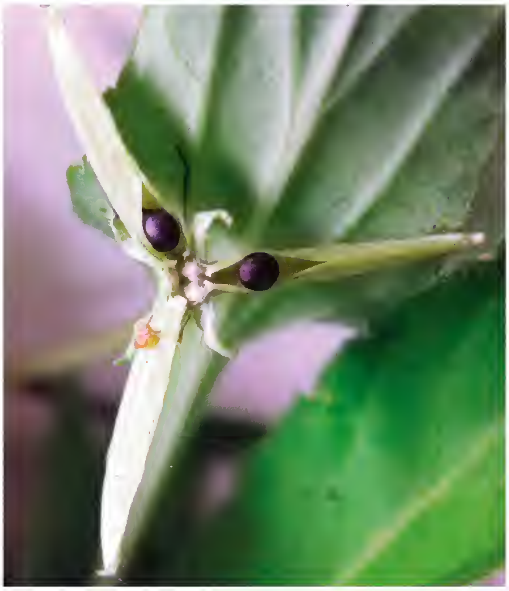

Fig. 7. One valve completely dehisced; 2 valves with one seed remaining at proximal end of valve. Photo: J. Little

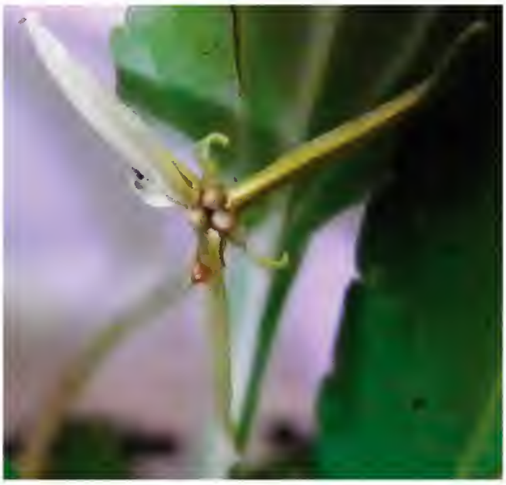

Fig. 8. Valves fully dehisced and completely clasped shut. Photo: J. Little

The second author timed a capsule that started opening at around 1400, was almost fully open at 1445, and was fully open at 1530. During the 45 minute interval between 1445 and 1530, some seeds were observed being ejected from the capsule. This capsule took about 1.5 hr to fully open and all seeds had been ejected by 1610. Thus, after it fully

Table 1. Seed dispersal times of *Viola betonicifolia* (Capsule A)

	No. of Seeds in Valve			
Time	**Valve 1**	**Valve 2**	**Valve 3**	**Total**
1121	13	11	11	35
1300	9	4	6	19
1303	8	4	6	18
1304	8	4	5	17
1311	5	4	0	9
1312	5	0	0	5
1338	2	0	0	2
1339	0	0	0	0

Table 2. Seed dispersal times of *Viola betonicifolia* (Capsule B)

	No. of Seeds in Valve			
Time	**Valve 1**	**Valve 2**	**Valve 3**	**Total**
1603	4	4	2	10
1604	4	3	1	8
1610	0	1	1	2
1626	0	0	1	1
1715	0	0	0	0

opened, it took 40 minutes until all seeds were ejected (some seeds dispersed before it was fully open).

Seeds

In the ovary, the ovoid-shaped seeds are attached to the placenta at the narrow end of the seed at the location of the elaiosome. Typical of many *Viola* species, the seeds are smooth and shiny when fully mature and fresh (**Fig. 9**). Mature seeds appear black or brown. Under magnification, they appear mottled black and brown (**Fig. 9**). The elaiosome is white or whitish when fresh (**Fig. 9**). The mean number of seeds per CL capsule was 19 (n=7 capsules, 133 seeds; range 8–35; SD 8.42; **Table 3**). The mean number of seeds per capsule is considered preliminary; additional counts need to be made utilizing a larger data set. Raw data for seed lengths and widths are available from the authors.

Mean seed length was 1.44 mm (n=75 seeds, five capsules); range 1.10–1.71 mm; SD 0.160. The length of five seeds was not determined because they were inadvertently crushed when measured. The mean seed width was 1.11 mm (n=74 seeds, five capsules); range 0.98–1.30 mm; SD 0.075. The width of six seeds was not included because the colour of five was markedly paler than other seeds in the capsule and thus were assumed to not be fully mature and/or possibly not viable; another seed was inadvertently crushed when measured.

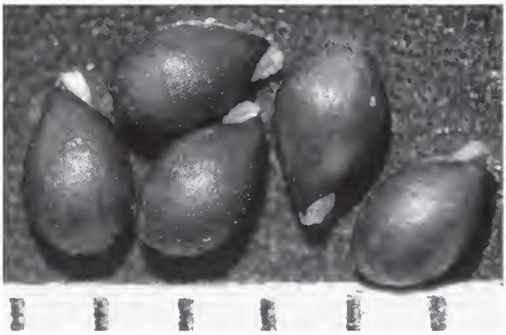

Fig. 9. *Viola betonicifolia* seeds emphasising elaiosomes. Lines are mm. Photo: J. Little

Dispersal Distances

The distances that seeds travelled after being ballistically ejected from capsule valves are summarized in **Table 4**. The mean distance for all seeds (n=85) was 148 cm; range 13–321 cm; SD 77.76.

The majority of seeds were dispersed a distance of 101 to 200 cm (**Fig. 10**). Two seeds exceeded 300 cm (306 and 321 cm).

Table 3. Numbers of seeds per capsule in *Viola betonicifolia*

Capsule No.	Number of seeds
1	15
2	15
3	19
4	8
5	23
6	18
7	35[a]

[a] Determined by first author; all others by second author.

Table 4. Seed dispersal distances in *Viola betonicifolia*

Dispersal Date	Temp (°C)	Total number of seeds per capsule	Mean distance/ Range/ Standard Deviation (SD)	Distances (cm)
19 February 2012	n/a	11	78.04 cm/ 17–154.5 cm; SD 41.36	17, 33.5, 37.5, 50, 72, 76.5, 95, 98.5, 106, 118, 154.5
22 February 2012	28.5	19	140 cm/ 13–256 cm; SD 66.36	13, 13.5, 56, 85, 90.5, 105, 132.5, 134.5, 139.5, 157, 159, 168, 174.5, 175, 175.5, 188.5, 210, 226.5, 256
1 March 2012	31.5	24	158.02 cm/ 27–253 cm; SD 67.85	27, 52.5, 55.5, 62, 79, 93.5, 104, 128, 133.5, 146.5, 161, 180, 188, 191.5, 198, 200.5, 204, 211.5, 213, 213, 224.5, 226, 247, 253
2 March 2012	31	15	181.16 cm/ 22.5–321 cm; SD 78.62	22.5, 83, 103, 141.5, 144, 150, 166.5, 177, 216, 217.5, 218, 226, 236.5, 295, 321
8 March 2012	28	16	161.06 cm/ 20–306 cm; SD 97.45	20, 33, 49.5, 76, 96.5, 106.5, 121.5, 141, 152.5, 177.5, 208.5, 215, 284, 294, 295.5, 306

Discussion

Cleistogamous flowers (CL)

We documented the presence of CL flowers in *Viola betonicifolia*. The presence or absence of CL flowers in this species is not mentioned in most Australian floras or guidebooks (Adams 1982; Stanley & Ross 1983; James 1990a,b; Robinson 1994; Entwisle 1996; Fairley & Moore 2000; Anon 2007; Duretto 2009; Elliot & Jones 2010). While not specifically mentioning cleistogamous flowers in *V. betonicifolia*, Williams (1979) referenced the presence of "self-pollinating flowers". Of the 73 *Viola* species in North American, 60 are known to produce CL flowers, nine species do not, and the condition in four species remains unknown (Little & McKinney in prep). The number of *Viola* species in the Australian flora that produce CL flowers has not been determined.

The fact that all CL capsules examined in this study contained mostly fertile seeds suggests that the pollination mechanism in CL flowers of *Viola betonicifolia* is highly efficient. Mayers & Lord (1983a,b) reported an interesting situation for *V. odorata* L. where the pollen grains in CL flowers germinate while still in the undehisced anther sacs; the

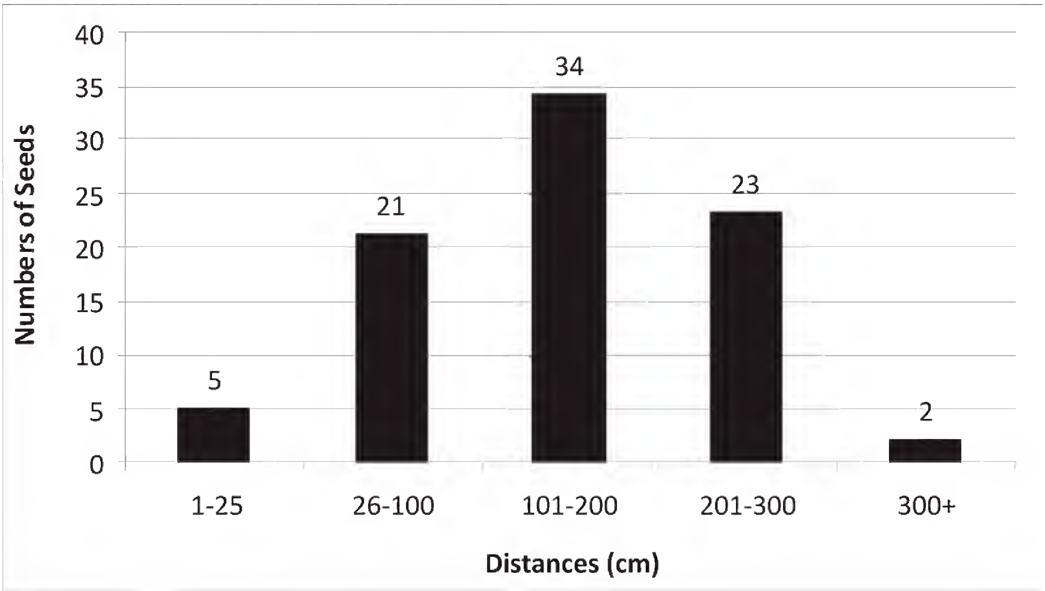

Fig. 10. Dispersal distance frequency histogram (n=84) for *Viola betonicifolia*

pollen tubes then penetrate the sac and grow out towards the nearby stigma. Karlsson *et al.* (2012) stated that preliminary observations in other *Viola* species suggest that pollen is simply released in close proximity to the stigma on the recurved style. The mechanism by which CL flowers of *V. betonicifolia* achieve self-pollination is unknown and needs study.

Capsules

Observations of mature capsules of *Viola betonicifolia* and other Australian species by the authors, and unpublished observations by the first author on several Californian species, show that the capsules of putatively diplochorous *Viola* species do not open 'explosively,' but instead open rather slowly. Based on this study and observations of other *Viola* species, the capsule itself does not 'explode.'

Capsules of *Viola* species that disperse seeds ballistically are usually on erect peduncles, whereas capsules that passively release their seeds (e.g. *V. odorata*) usually point downward (Beattie & Lyons 1975). Capsules of *V. betonicifolia* are on erect peduncles prior to seed dispersal, typical of diplochorous species that eject seeds ballistically. Upon drying, contraction of each of the three capsule valves squeezes the seeds, which are then ballistically ejected. We observed that *V. betonicifolia* seeds were sometimes ejected before the valves were completely open. This occurrence needs to be taken into account when determining the total number of seeds per valve and per capsule.

The morphology of mature capsules of CH and CL flowers are indistinguishable. Only CL capsules were available for this study. Dispersal in CH capsules has not been studied. However, based on observations of CH capsules of other *Viola* species in Australia and California, we suspect that CH capsules of *V. betonicifolia* dehisce in a manner similar to CL capsules. Although empirical data are not available, it seems plausible that temperature, humidity, and soil moisture are important factors in the length of time it takes for a capsule to change from an inverted to an upright position, to split open, and to begin dehiscing seeds.

How long does it take a mature capsule to open? Based on one capsule that was timed, it took 1.5 hr to fully open. Although only one capsule was timed, it was observed that all capsules opened slowly. None ‘exploded’ in a spontaneous release of seeds. After a capsule is fully open, how long before seeds begin to disperse? Data from two capsules showed that one took 2.3 hr while another took 40 minutes to disperse all their seeds. Are seeds randomly dispersed from a valve or is there a pattern? We observed that seeds were dispersed first from the centre and then randomly from either the proximal or distal ends of the valve. Beattie & Lyons (1975) observed that seeds of *Viola* species they studied were usually dispersed first from the centre of the valve.

Seeds and Dispersal Distances

The position of the individual valves relative to ground level prior to dehiscence affects the trajectory and dispersal distance for a given seed. The seed dispersal distances that we report are measures of the horizontal distance from the plant and may not reflect the actual distance travelled. For example, a seed could be ejected 200 cm vertically, but land only 20 cm from the plant. The dispersal distance in this case would be measured as 20 cm. We did in fact observe that some seeds were expelled vertically while others were expelled ± horizontally. Further research is needed to determine if position in the valve correlates with the distance a seed is ejected, other factors being equal.

The mean dispersal distance for all *Viola betonicifolia* seeds was 149 cm (n=84), range 13–321 cm. The frequency histogram of dispersal distances approximates a bell curve (**Fig. 10**). Dispersal distances of seeds from *V. betonicifolia* CH flowers remain to be determined.

Beattie & Lyons (1975) reported distances of ballistically dispersed seeds for CH capsules of seven perennial *Viola* species native to eastern North America. They also reported data for CL capsules for three of the seven species they studied (*V. striata* Aiton, *V. blanda* Willd. and *V. papilionacea* = *V. sororia* Willd. var. *sororia*). Because dispersal distances of seeds from CH capsules were longer for each species compared to CL capsules, a reasonable comparison of Beattie & Lyons’ (1975) data with *V. betonicifolia* was made by considering only the results from CL capsules: *V. striata*, mean dispersal distance was 110 cm (n=50), range 20–220 cm; *V. blanda*, mean dispersal distance was 80 cm (n=18), range 30–220 cm; and *V. papilionacea*, mean dispersal distance was 100 cm (n=527), range 2–210 cm. The mean dispersal distance of *V. betonicifolia* seeds from CL capsules (149 cm) exceeded the three species reported by Beattie & Lyons (1975) by 110, 80, and 100 cm. In addition, the maximum dispersal distance of *V. betonicifolia* (321 cm) exceeded the three species reported by Beattie & Lyons (1975) of 220, 220, and 210 cm.

Forster (2007) documented that ballistically ejected seeds of *Euphorbia obesa* Hook. (Euphorbiaceae) were viscid resulting in their sticking to soil, pebbles and vegetation. We found *Viola betonicifolia* seeds were buoyant in water, but not viscid and thus do not stick to surfaces. In coastal areas of Queensland, *V. betonicifolia* grows with *Melaleuca quinquenervia* (Cav.) S.T.Blake in swampy areas that become seasonally or periodically inundated from rainwater. In addition to ants, seed dispersal may be facilitated by being buoyant and transported in water during storm events. The potential that dispersal of *Viola* seeds can be facilitated by water has not been investigated. Anecdotal observations of *V. betonicifolia* plants growing in ‘lines’ in coastal wetlands in Queensland where water has obviously carried them and receded (pers. comm., F. Jordan), suggests that water dispersal may be an important, heretofore overlooked mechanism for dispersal of this species in Australia.

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A revision of *Calyptochloa* C.E.Hubb. (Poaceae), with two new species and a new subspecies

E.J. Thompson & B.K. Simon

Summary

Thompson, E.J. & Simon, B.K. (2012). A revision of *Calyptochloa* C.E.Hubb. (Poaceae), with two new species and a new subspecies. ***Austrobaileya* 8(4): 634–652.** Two new species of *Calyptochloa* C.E.Hubb. (*Calyptochloa cylindrosperma* E.J.Thomps. & B.K.Simon and *C. johnsoniana* E.J.Thomps. & B.K.Simon) endemic to central Queensland, and a new subspecies of *Calyptochloa gracillima* C.E.Hubb. (*C. gracillima* subsp. *ipsviciensis* E.J.Thomps. & B.K.Simon) endemic to southeast Queensland are described and illustrated.

Key Words: Poaceae, Paniceae, panicoid, cleistogamous, *Calyptochloa*, *Calyptochloa cylindrosperma*, *Calyptochloa gracillima* subsp. *gracillima*, *Calyptochloa gracillima* subsp. *ipsviciensis*, *Calyptochloa johnsoniana*, *Cleistochloa*, Queensland flora, taxonomy, new species, new subspecies, identification key

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Introduction

Calyptochloa C.E.Hubb., an endemic Australian genus, is placed in the subfamily *Panicoideae* Link, tribe *Paniceae* R.Br. This tribe is characterised by the spikelets having a pair of dimorphic florets with the lower often incomplete, male or sterile, and falling entire, the upper fertile, and by the relative induration of the glumes and lemmas (Clayton & Renvoize 1986; Kellogg & Campbell 1987). *Calyptochloa* is amphigamous by having two types of inflorescences, *viz.* in terminal and axillary positions. The terminal inflorescence (Connor 1979), is a spike-like raceme with chasmogamous (CH) pedicillate spikelets that open at maturity and thereby potentially cross-fertilise. Conversely, the axillary inflorescence usually consists of a single sessile cleistogamous (enclosed self-fertilising flowers) (CL) spikelet which is hidden within semi-woody to woody leaf sheaths at each of several nodes along the culm. In the summer wet season, the axillary spikelets are produced at nodes with the terminal inflorescence above. At other times of the year, these chains of axillary spikelets may be produced in the absence of terminal inflorescences. Webster (1987) stated that the CL spikelets occur singly or in pairs but we have not observed paired spikelets in any specimens at BRI, including those cited by Webster (1987), until we examined the type specimen for one of the new species described herein (*Calyptochloa johnsoniana* E.J.Thomps. & B.K.Simon). In *Calyptochloa*, the CL spikelets are obligately self-fertilised and never open. Plants of *Calyptochloa* retain the CL spikelets for a few months enclosed in the leaf sheaths before disarticulation at the culm nodes or at the leaf sheath bases which then fall at maturity with subsequent dispersal of the caryopses.

Calyptochloa has remained a monotypic genus since description with only *C. gracillima* C.E.Hubb. recognised until now (Hubbard 1933b; Tothill & Hacker 1983). The genus is characterised by the perennial mat-forming growth habit and the fertile leaf sheaths which enclose the CL spikelets. Clifford & Ludlow (1972) differentiated *Calyptochloa* from other Queensland grass genera in their key using “stems disarticulating at the nodes at maturity” and “prostrate to creeping” habit.

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The genus is both clonal (stoloniferous) and cleistogamous, a rare combination in grasses (Campbell *et al.* 1983).

Cleistochloa C.E.Hubb. (Hubbard 1933a), another perennial panicoid genus from Australia and New Guinea, was listed by Connor (1981) with *Calyptochloa* amongst 13 genera world wide that possess clandestine axillary CL spikelets and belong in four different subfamilies of the Poaceae. Seven of these genera have amphigamous inflorescences and dimorphic spikelets of which *Calyptochloa* and *Cleistochloa* are the only panicoid genera. *Dimorphochloa* S.T.Blake (Blake 1941; Simon *et al.* 2010), which is also an Australian CL panicoid genus, was correctly omitted from Connor's (1981) list taking into account that this genus had not been synonymised with *Cleistochloa* (Clayton & Renvoize 1986; Webster 1987) at the time. Although *Dimorphochloa* has amphigamous inflorescences it differs from these other genera in terms of the CL spikelets as follows: similar to the CH spikelets, located apically on branchlets below the terminal inflorescences, and not hidden in the leaf sheaths at anthesis. *Amphicarpum* Kunth, another CL panicoid genus from eastern North America, was also omitted from Connor's (1981) list. *Amphicarpum* has amphigamous inflorescences and dimorphic spikelets but differs by the subterranean CL spikelets (rhizanthogenes) which are borne at the tips of rhizomes.

Connor (1981) reported that the clandestine spikelets are a secondary source of seed with most of the seed produced in the terminal inflorescences. For the Australian genera the reverse is true with most or all of the caryopses produced in the CL spikelets. Of about 30 specimens of *Calyptochloa gracillima* possessing terminal inflorescences inspected at BRI, only one had CH caryopses. No specimens of *Cleistochloa* at BRI were observed to have CH caryopses, thereby confirming this same observation made by Hubbard (1933a). The Australian genera with clandestine spikelets share features, indicative of obligate or habitual cleistogamy (Connor 1979), which when compared to the CH spikelets (Campbell *et al.* 1983) include the following:

a) reduced CL inflorescence size, usually one spikelet compared to a raceme or reduced panicle
b) CL lodicules absent
c) reduced size of CL anthers usually enravelled in reduced styles
d) upper floret with lemma and palea convolute towards the apex tightly enclosing the anthers and styles at anthesis compared to gaping, and
e) the CL caryopses a little larger than the CH caryopses when present.

Campbell *et al.* (1983) provided a detailed classification of CL species comprising four types based on factors that relate to prevention of the spikelets from opening including leaf sheath, spikelet parts or the soil conditions. Campbell *et al.* (1983) classified *Calyptochloa* and *Cleistochloa* as type II where fertilisation occurs in spikelets hidden in the lowermost sheaths and this type is usually associated with major inflorescence and spikelet differentiation. Chase (1908) referred to these clandestine CL spikelets at or near the ground as cleistogenes. However, *Calyptochloa* and *Cleistochloa* have CL spikelets enclosed in the sheaths in upper axils at fertilisation and the upper floret has modifications including revolute lemma and palea, and lodicules are absent, which prevent the floret from opening. These characteristics match type 1 of Campbell *et al.* (1983) , where fertilisation takes place within the leaf sheaths of the middle to upper part of the stem but the spikelet may be exserted at maturity.

Hubbard (1933a) stated that as for the American CL grasses, the Australian species are found in arid regions or dry places within humid regions. *Calyptochloa* is distributed from tropical central Queensland with hot humid summers and monsoonal wet season to warm temperate south-eastern Queensland with warm humid summers (**Map 1**). *Calyptochloa* spp. are found in mostly well shaded habitats in a variety of vegetation communities frequently dominated by *Acacia* spp. on gently undulating to steeply sloping terrain with shallow to skeletal soils derived from a variety of geology but often on landscapes with lateritic profiles.

In the current paper we provide a taxonomic account of *Calyptochloa*, trebling the number of species. Some of these additional species have been recognised for some time; however, their description is now possible following collection of material critical for character delimitation. Other taxa currently listed under *Calyptochloa* include *C.* sp. (Charters Towers E.J.Thompson+ CHA554) (Simon *et al.* 2010) and *C.* sp. (Duaringa K.D.Addison 42) (in BRI HERBRECS database accessed July 2012); both have same similar features to the species described in this paper, but may ultimately be described in other genera. These taxa are new members of the group of Australian panicoid grasses with axillary CL spikelets and are the subject of further study. They have overlapping distribution and habitat to other members of the group and often occur with *Thyridolepis xerophila* (Domin) S.T.Blake which is also a CL panicoid grass but the CL spikelets are in the terminal inflorescences and this species lacks axillary spikelets. On a number of occasions up to three to four of these CL species have been observed growing together.

Materials and methods

Morphological data were obtained from dried herbarium material at BRI, and from cultivated plants transplanted from the field. Numerous terminal spikelets and leaf sheaths were dissected to examine the contents and describe the characteristics of the spikelets. Caryopsis germination trials were conducted during one summer over a two month period using sealable containers in outdoor conditions with periods of direct sunlight and no artificial lighting, shade or heating.

Habitat descriptions provided include Regional Ecosystems (REs) which are defined by DERM (2011). Botanical terminology follows Beentje (2010). Common abbreviations used in specimen citations include N.P. (National Park), S.F. (State Forest).

Taxonomy

Calyptochloa C.E.Hubb., *Hook. Icon. Pl.* 33: t. 3210 (1933). **Type species**: *C. gracillima* C.E.Hubb.

Decumbent mat forming perennials; rhizomes absent. Stolons wiry, *c.* 1 mm thick; mid-culm internodes hollow. Culms differentiated, sterile and fertile, ascending from stolons. Fertile culms preceded by a portion of sterile culm; disarticulating at nodes or retained. Leaves ultimately disarticulating; margin undulate on one side, thickened, scabrid, white, with scattered tubercle-based hairs to 4 mm long at least at base; adaxial surface usually with scattered to moderately dense, erect simple hairs; abaxial surface with moderately dense, erect simple hairs. Mature fertile leaf sheaths disarticulating or retained, semi-woody to woody, enclosing from *c.* half to most of the length of the internode with scattered appressed to ascending tubercle-based bristles between ribs, with or without simple hairs; outer margin with dense, simple appressed to ascending simple hairs. Fertile culm internodes retained within leaf sheaths or bowing and protruding, scabrid along ribs with occasional simple hairs to 0.5 mm long between ribs. Sterile leaf sheaths retained; usually two types of hairs, with scattered appressed to ascending stiff tubercle-based hairs and sometimes ascending simple hairs. Sterile culm internodes with moderately dense to dense appressed to ascending, normal to flagelliform simple hairs to 2 mm long between ribs. Ligule a fringe of hairs, *c.* 0.3 mm long. Inflorescences of two kinds, chasmogamous terminal and cleistogamous axillary. Terminal inflorescences spike-like. Spikelets appressed to rachis, pedicillate, adaxial, elliptic, dorsiventrally compressed. Lower glume flat, chartaceous, glabrous except at base, apex acute; frequently absent, if present then restricted to apical spikelets. Upper glume as long as spikelet, ovate, flat, chartaceous, 5-nerved, dense simple hairs at base and usually moderately dense simple hairs to 2 mm over lower 30 to 60% and most of margin, upper portion glabrous; apex acute to truncate. Rachilla inconspicuous between florets. Lower floret sterile; lemma ovate, flat, chartaceous, densely hairy with simple hairs at base and moderately hairy over lower 60 to 80%, upper portion glabrous, margin moderately hairy with hairs to 2 mm long; apex acute to obtuse. Palea absent. Upper floret fertile, shorter than the lower and slightly indurated; lemma ovate in dorsiventral view, convolute, chartaceous, glabrous, 3-nerved, apex acute with minutely scabrid awn; palea ovate, convolute, chartaceous, glabrous, 2-nerved; apex acute. Lodicules, 2. Anthers, 3. Caryopsis rarely present. Axillary inflorescences usually a single cleistogamous spikelet at 5–10 contiguous culm internodes often from immediately below terminal inflorescence; spikelets enclosed within leaf sheaths which are scarsely enlarged to conspicuously swollen towards the base where the walls are thicker, semi-woody to woody. Spikelets sessile, adaxial, narrow elliptic in dorsiventral view, slightly indurated. Lower glume absent. Upper glume lanceolate, flat, shorter than spikelet, chartaceous, glabrous except for base with scattered short simple hairs, 3-nerved; apex acute to truncate. Rachilla inconspicuous between florets. Lower floret sterile; lemma elliptic, boat-shaped, two-keeled, chartaceous, glabrous except for base, 5-nerved; apex obtuse. Palea absent. Upper floret fertile, more than *c.* 80% of length of first; lemma lanceolate, convolute, chartaceous, glabrous, apex acute with minutely scabrid awn; palea lanceolate, convolute, chartaceous, glabrous, obscurely 5-nerved; apex acute to shortly awned. Lodicules absent. Stamens 3. Caryopsis tan to light brown, shallowly grooved at least on lower half, on adaxial face; hylum broadly elliptic, *c.* 40% of caryopsis length.

***Notes*:** *Calyptochloa* differs from the other Australian cleistogamous panicoid genera by having terminal spikelets dorsi-ventrally compressed compared to spikelets elliptic in cross-section; the upper floret of the terminal spikelets about 60 to 70% of the spikelet length compared to equal to the spikelet length; the axillary spikelets retained within semi-woody to woody leaf sheaths compared to the spikelets exposed, partially hidden or hidden within cartilaginous leaf sheaths; axillary spikelets lacking spongy tissue at the base of the lower lemma; axillary caryopsis grooved on the adaxial face compared to face convex; and differential indumentum type on the sterile and fertile culm internodes compared to little or no difference in the indumentum types.

Preliminary results from caryopsis germination and seedling trials for most of the *Calyptochloa* spp. recognised here, indicate some variation in dormancy, cotyledon characters and seedling survival. Germination for the trial was sporadic but frequently temporally clustered giving an impression that dormancy may be broken by a period of several hot days. Seedling survival was poor for most taxa suggesting that survival may be affected by nutrient status and/or acidity of the potting medium and is potentially dependent on mycorrhiza. Investigations are continuing into these aspects.

Key to *Calyptochloa* species

1 Fertile culm internode bowed and protruding from leaf sheath with chartaceous margins; axillary spikelet with upper glume >4.8 mm long; upper glume of terminal spikelets scabrid in mid third portion . . **3. C. johnsoniana**

1. Fertile culm internode retained within leaf sheath with margins semi-woody to woody; axillary spikelet with upper glume <4.5 mm long; upper glume of terminal spikelets sparsely hairy to pilose with simple hairs to 1 mm long in mid third portion **2**

2 Lower portion of fertile leaf sheath conspicuously swollen to 2.7 mm wide, wall 0.3–0.5 mm thick; axillary spikelets 3.5–5.5 mm long (excluding awn); terminal spikelets 3–4.6 mm long (excluding awn) **1. C. gracillima**

2. Lower portion of fertile leaf sheath slightly swollen to 1.4 mm wide, wall 0.2–0.3 mm thick; axillary spikelets 6–7.5 mm long (excluding awn); terminal spikelets 5–6 mm long (excluding awn) . . . . **2. C. cylindrosperma**

1. Calyptochloa gracillima C.E.Hubb., *Hook. Icon. Pl.* 33: t. 3210, 1–6 (1933). **Type:** Queensland. Burnett District: Munduberra, April 1931, *H.S.Bloxsome 9* (holo: BRI; iso: BRI, K [photo BRI]).

Decumbent stoloniferous perennial. Ascending branches to 40 cm tall, copiously branched with 7–30 nodes. Stolons to *c.* 2 m long. Mid-culm leaf blades 12–40 mm long, 2.5–6 mm wide; adaxial surface with sparse hairs 0.5–2 mm long; abaxial surface with moderately dense simple hairs 0.5–1 mm long. Mature fertile leaf sheaths retained, convolute, woody. Fertile culm internodes 14–40 mm long. Sterile leaf sheaths with or without tubercle-based bristles 0.3–0.8 mm long and occasionally simple hairs 1.5–3 mm long; outer margin hairs dense, 0.4–1 mm long. Terminal inflorescences on axes 1.5–3 cm long, 5–8-flowered. Spikelets 2.3–5 mm long (without awn), 1–1.8 mm wide; lateral pedicels 0.3–1.6 mm long; ultimate pedicel 2.5–5.5 mm long. Lower glume triangular to lanceolate, 0.2–1.8 mm long; apex acute. Upper glume 3–5 mm long. Lower lemma 2.3–5 mm long; apex acute. Upper lemma 2.2–3.5 mm long, awn 0.5–3 mm long; lodicules *c.* 0.2 mm long; palea 2–3 mm long, rarely awned. Anther 1.5–2 mm long. Caryopsis (**1.6–1.8**) 2.2–2.5 mm, rarely present. Axillary inflorescences present at 3–10 internodes. Spikelets 3.5–5.5 mm long (without awn), 0.8–1.1 mm wide. Upper glume 0.5–3.5 mm long, apex acute. Lower lemma 3–5.5 mm long. Upper floret subequal to lower. Upper lemma body 3.5–5.5 mm long, awn 0.5–2.6 mm long; palea 3–3.8 mm long. Anthers 0.3–0.7 mm long. Caryopsis approximately plano-convex, 2–3.5 mm long, 0.7–0.8 mm wide. Measurements **in bold** type are from Hubbard (1933b) and were not repeatable from the specimens examined.

Key to subspecies of *Calyptochloa gracillima*

1a Axillary spikelets 4–5.5 mm long (excluding awn) × 1–1.1 mm wide, anthers 0.3–0.4 mm long; terminal spikelets with lower glume when present *c.* 0.2 mm long and upper glume apex obtuse to truncate . . . . **C. gracillima** subsp. **gracillima**

1b Axillary spikelets 3.5–4.2 mm long (excluding awn) × 0.8–0.9 mm wide, anthers 0.4–0.7 mm long; terminal spikelets with lower glume when present 0.8–1.8 mm long and upper glume apex acute . . **C. gracillima** subsp. **ipsviciensis**

1a. C. gracillima subsp. **gracillima**

Decumbent stoloniferous perennial. Ascending branches to 25 cm tall, copiously branched with 10–30 nodes. Stolons to *c.* 1.5 m long. Mid-culm leaf blades 25–40 mm long, 2.5–5 mm wide; adaxial surface with sparse to moderately dense simple hairs 0.3–1.6 mm long and usually some tubercle based hairs to 3 mm long on margin at base; abaxial surface with moderately dense simple hairs 0.2–0.8 mm long. Mature fertile leaf sheaths 10–17 mm long, 1.5–3 mm wide near base with wall 0.3–0.4 mm thick. Sterile leaf sheaths with tubercle-based bristles *c.* 0.3 mm long and simple hairs *c.* 1.3 mm long. Terminal inflorescences on axes 1–3 cm long, 5–8-flowered. Spikelets 3–5 mm long (without awn), 1.3–1.8 mm wide; lateral pedicels 0.4–2 mm long, apical pedicel 2–4.5 mm long. Lower glume triangular to lanceolate, 0.2–1.3 mm long. Upper glume 3–5 mm long; apex truncate. Lower lemma 3–5 mm long. Upper lemma 3–3.5 mm long, awn 2–3 mm long; lodicules 0.2–0.4 mm long; palea 2.5–3 mm long, rarely awned, awn to 2 mm long. Anthers (**0.5–1**) 1.6–2 mm long. Caryopsis (**1.6–1.8**) *c.* 2.3, rarely seen. Axillary inflorescences usually present at 5 (3–10) internodes. Spikelets 4–5.5 mm long (without awn), 1–1.1 mm wide. Upper glume 0.5–1.5 mm long. Lower lemma 4–5.5 mm long. Upper lemma body 4–5.5 mm long, awn 2–2.6 mm long; palea 3–3.8 mm long. Anthers 0.3–0.4 mm long. Caryopsis 2–3.5 mm long, 0.7–0.8 mm wide. **Fig. 1 & 2.**

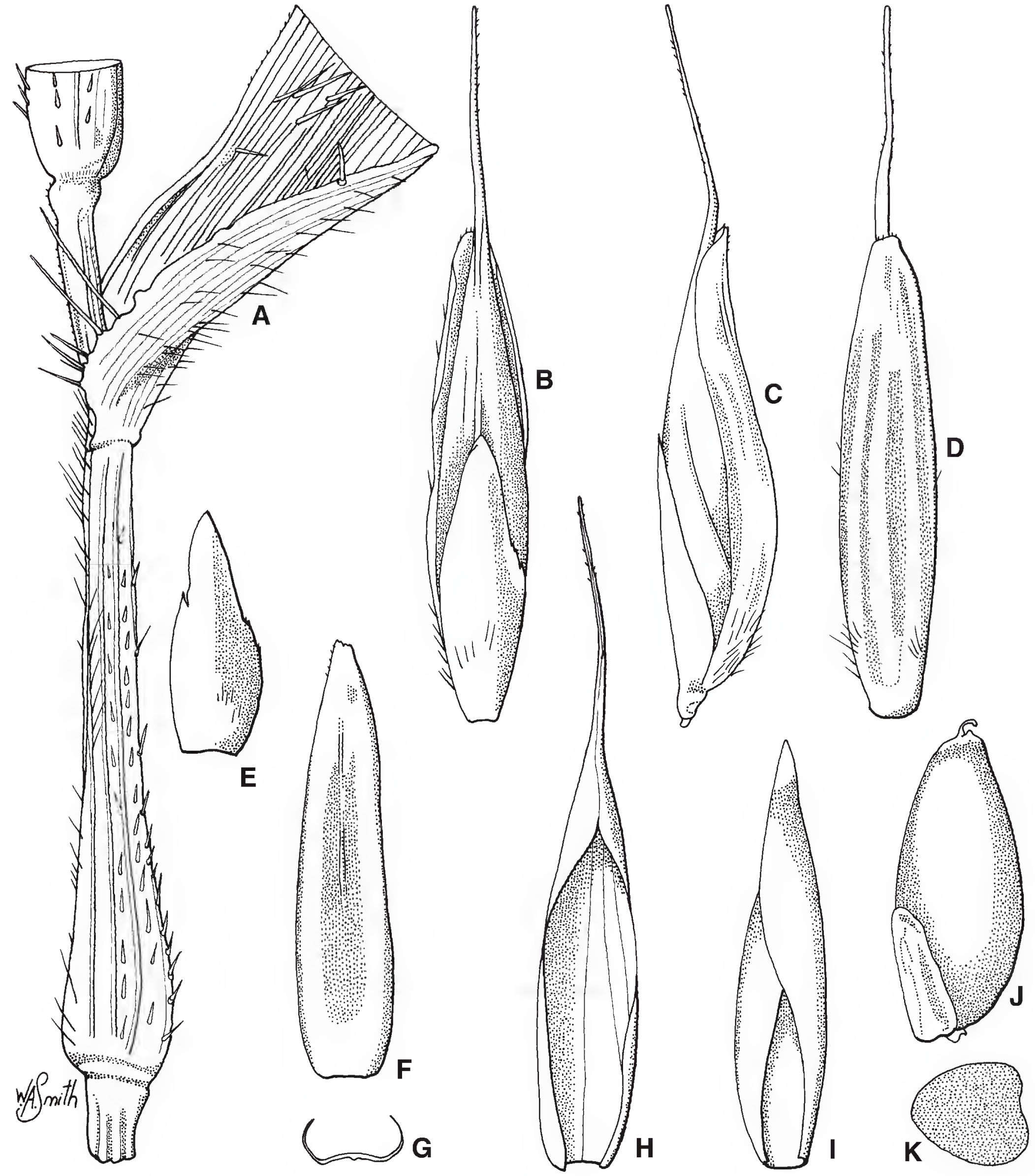

Fig. 1. Axillary spikelet of ***Calyptochloa gracillima*** subsp. ***gracillima***. A. leaf sheath enclosing axillary spikelet ×8. B. upper glume facing ×12. C. side view ×12. D. lower lemma facing ×12. E. upper glume ×12. F. lower lemma ×12. G. cross-sectional view of lower lemma ×12. H. upper lemma ×12. I. upper palea ×12. J. caryopsis ×16. K. cross-sectional view of caryopsis ×16. A–K from *Blake 19976* (BRI). Del. W.Smith.

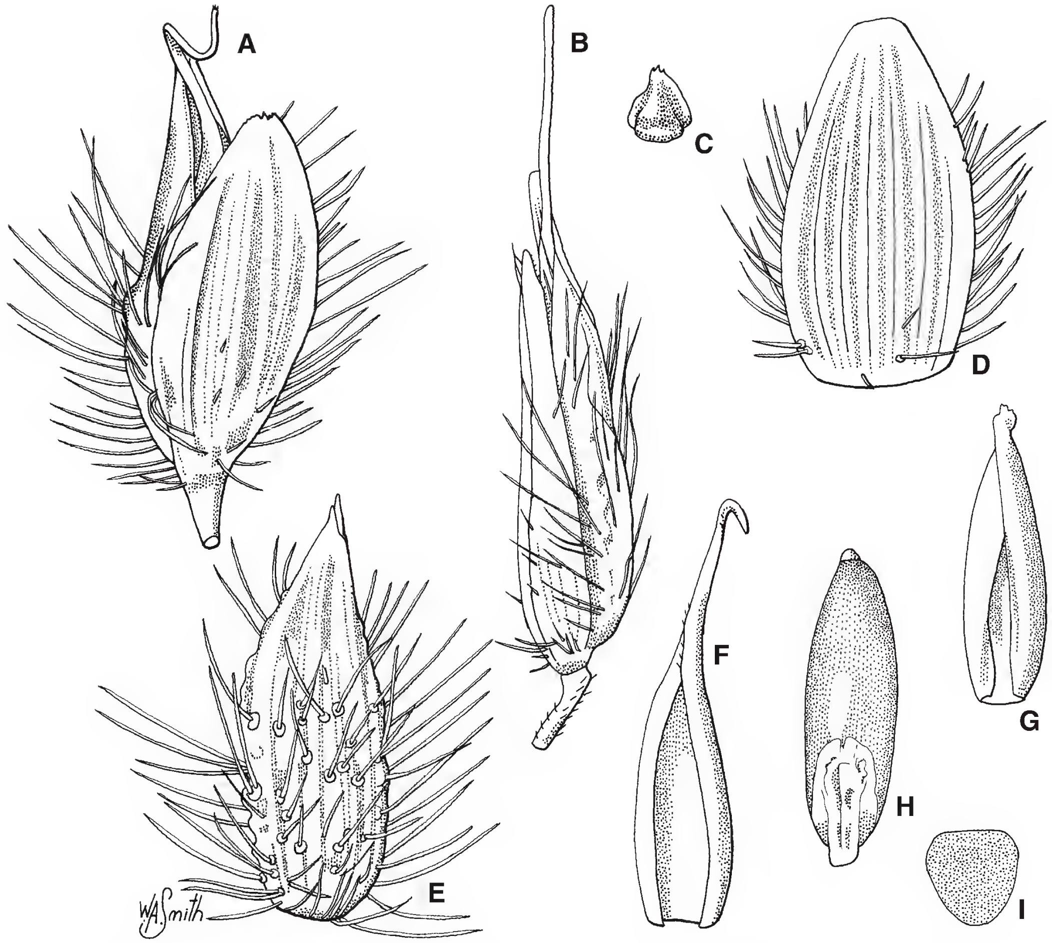

Fig. 2. Terminal spikelet of ***Calyptochloa gracillima*** subsp. ***gracillima***. A. upper glume facing ×16. B. side view ×16. C. lower glume ×24. D. upper glume ×16. E. lower lemma facing ×16. F. upper lemma ×16. G. upper palea ×16. H. caryopsis ×16. I. cross-sectional view of caryopsis ×16. A–F from *Blake 19976* (BRI); H–I from *Bean 20216* (BRI). Del. W.Smith.

Measurements in **bold** type are from Hubbard (1933b) which were not repeatable from the specimens examined.

***Additional selected specimens examined*: Queensland.** North Kennedy District: On edge of road 70 km SSE of Charters Towers, May 2012, *Thompson & Simon CHA795* (BRI). South Kennedy District: Edge of highway, 53 km NW of Clermont, May 2012, *Thompson & Simon EJT875* (BRI); 4 km (direct) NW of haul road overpass, near Newlands coal mine, WNW of Glendon, Jun 2009, *Bean 29028*, (BRI). Leichhardt District: Edge of road, 34 km SW of Springsure, Apr 2012, *Thompson & Simon EJT830* (BRI); site of Brigalow Research Station, 20 miles [32 km] NW of Theodore, Apr 1963, *Johnson 2642* (BRI); 17 km W of Baralaba, on road to Woorabinda, Mar 2005, *Bean 23519* (BRI); Near Bun Bun Kundoo Spring, Ka Ka Mundi N.P., via Springsure, May 1999, *Bean 14846* (BRI); 16.6 km along Roche Creek Road, E of Wandoan, Mar 2010, *Bean 29485* (BRI). Port Curtis District: Gogango, May 1956, *Blake 19976*, (BRI); Marmor, Mar 1943, *Blake 14819* (BRI); Hibbs Road, N of Jambin, Apr 2003, *Bean 20216* (BRI). Maranoa District: 20 miles [32 km] W of Mitchell, Mar 1936, *Blake 10951* (BRI). Darling Downs District: Edge of track, Barakula S.F., 32 km NW of Chinchilla, Apr 2012, *Thompson & Simon EJT786* (BRI).

***Distribution and habitat*:** *Calyptochloa gracillima* subsp. *gracillima* is endemic to central Queensland (**Map 1**). At its most southern limits, it occurs on a range of soil types e.g. clay under brigalow (*Acacia* *harpophylla* F.Muell. ex Benth.) (RE 11.3.1), sandy duplex soils to skeletal soils on laterite and shallow sandy soils on sandstone in ironbark woodland (commonly *Eucalyptus fibrosa* subsp. *nubila* (Maiden & Blakely) L.A.S.Johnson) (RE 10.7.7). Other REs represented include 11.5.3 and 11.5.4. Further north it occurs on mostly lateritic landscapes overlapping with the distribution area of *C. cylindrosperma* but the two species are rarely seen together. REs represented include 11.7.2 and 11.7.6. *C. gracillima* subsp. *gracillima* has a much broader habitat range than *C. cylindrosperma*, *C. johnsoniana* and *C. gracillima* subsp. *ipsviciensis*, which is also reflected in its broader overall distribution.

Phenology: *Calyptochloa gracillima* subsp. *gracillima* flowers from December to March during the wet season. The cleistogamous spikelets are produced over a broader seasonal period.

Notes: Caryopsis germination trials indicate differences between the subspecies of *Calyptochloa gracillima*. Initial trials have revealed more rapid germination of *C. gracillima* subsp. *ipsviciensis* and better seedling survival than for the nominative subspecies.

Conservation status: This subspecies is widely distributed over a large area and is usually common in the habitats where it occurs suggesting this subspecies is **Least Concern** (IUCN 2001).

1b. Calyptochloa gracillima subsp. **ipsviciensis** E.J.Thomps. & B.K.Simon, **subspecies nova** similar to *C. gracillima* C.E.Hubb. subsp. *gracillima* differing by the axillary spikelets mostly shorter (3.5–4.2 mm versus 4–5.5 mm) and narrower (0.8–0.9 mm versus 1–1.1 mm); longer anthers (0.4–0.7 versus 0.3–0.4); and by the terminal spikelets with an acute apex of upper glume (versus obtuse to truncate), and longer lower glumes when present (0.8–1.8 mm versus <0.2 mm). **Typus:** Queensland, Moreton District: Council reserve, cnr Reservoir Lane and Kholo Road, Ipswich, 4 April 2012, *E.J.Thompson MOR711* (holo: BRI; iso: CANB, K, L, MO, NSW, SI, US).

Decumbent stoloniferous perennial. Ascending branches to 40 cm tall, copiously branched with 10–30 nodes. Stolons to *c.* 3 m long. Mid-culm leaf blades 20–36 mm long, 2.5–5 mm wide; adaxial surface with sparse hairs 0.5–2 mm long; abaxial surface with moderately dense simple hairs 0.5–1 mm long. Mature fertile leaf sheaths 10–15 mm long, 1.2–2.5 mm wide near base with wall 0.3–0.4 mm thick. Sterile leaf sheaths with tubercle-based bristles 0.3–0.7 mm long and simple hairs 1.5–3 mm long. Terminal inflorescences on axes 1.5–3 cm long, 5–8-flowered. Spikelets 3–4.6 mm long (without awn), 1–1.6 mm wide; lateral pedicels 1–1.6 mm long, apical pedicel 2.5–4 mm long. Lower glume lanceolate, 0.7–1.8 mm long. Upper glume 2.3–4.6 mm long; apex acute. Lower lemma 2.3–4.6 mm long. Upper floret lemma 2.2–3.2 mm long, awn 0.5–2.4 mm long; lodicules 0.2 mm long; palea 2–2.7 mm long, apex acute. Anther, 1.5–2 mm long. Caryopsis not seen. Axillary inflorescences usually present at 4 (3–5) internodes. Spikelets 3.5–4.2 mm long (without awn), 0.8–1 mm wide. Upper glume 0.7–3.5 mm long. Lower lemma 3.5–4.2 mm long. Upper lemma body 3–4.2 mm long, awn 0.5–2.5 mm long; palea 2.7–3.5 mm long. Anthers 0.4–0.5 mm long. Caryopsis 2.3–3.7 mm long, 0.5–0.8 mm wide. **Fig. 3 & 4**.

***Additional specimens examined*: Queensland.** Moreton District: Edge of powerline easement off South Deebing Creek Road, Deebing Heights, Feb 2012, *Thompson MOR689 & Simon* (BRI, CANB, K, SI); Edge of Kerners Road, Yamanto near Ipswich, Aug 2011, *Thompson EJT497* (BRI, CANB, MO); Edge of Kerners Road, Yamanto near Ipswich, Feb 2012, *Thompson MOR688 & Simon* (BRI); Council reserve, corner Reservior Lane and Kholo Road, Ipswich, May 2002, *Thompson MOR739 & Simon* (BRI): Ipswich Council reserve, end of Powers Road, off Kholo Road, *c.* 1 km S of Brisbane River crossing, *c.* 6 km N of Ipswich; Mar 2012, *Thompson MOR709* (BRI); Edge of Kholo Road, *c.* 1 km SE of Brisbane River crossing near corner of Blackwall Road, *c.* 6 km N of Ipswich, Mar 2012, *Thompson MOR693* (BRI, CANB, NSW, RSA).

Distribution and habitat: *Calyptochloa gracillima* subsp. *ipsviciensis* is endemic to southeast Queensland in the vicinity of Ipswich (**Map 1**) where it is known from a few small areas. It is an uncommon to dominant species in woodlands dominated by *Eucalyptus* spp. including *E. crebra* F.Muell.

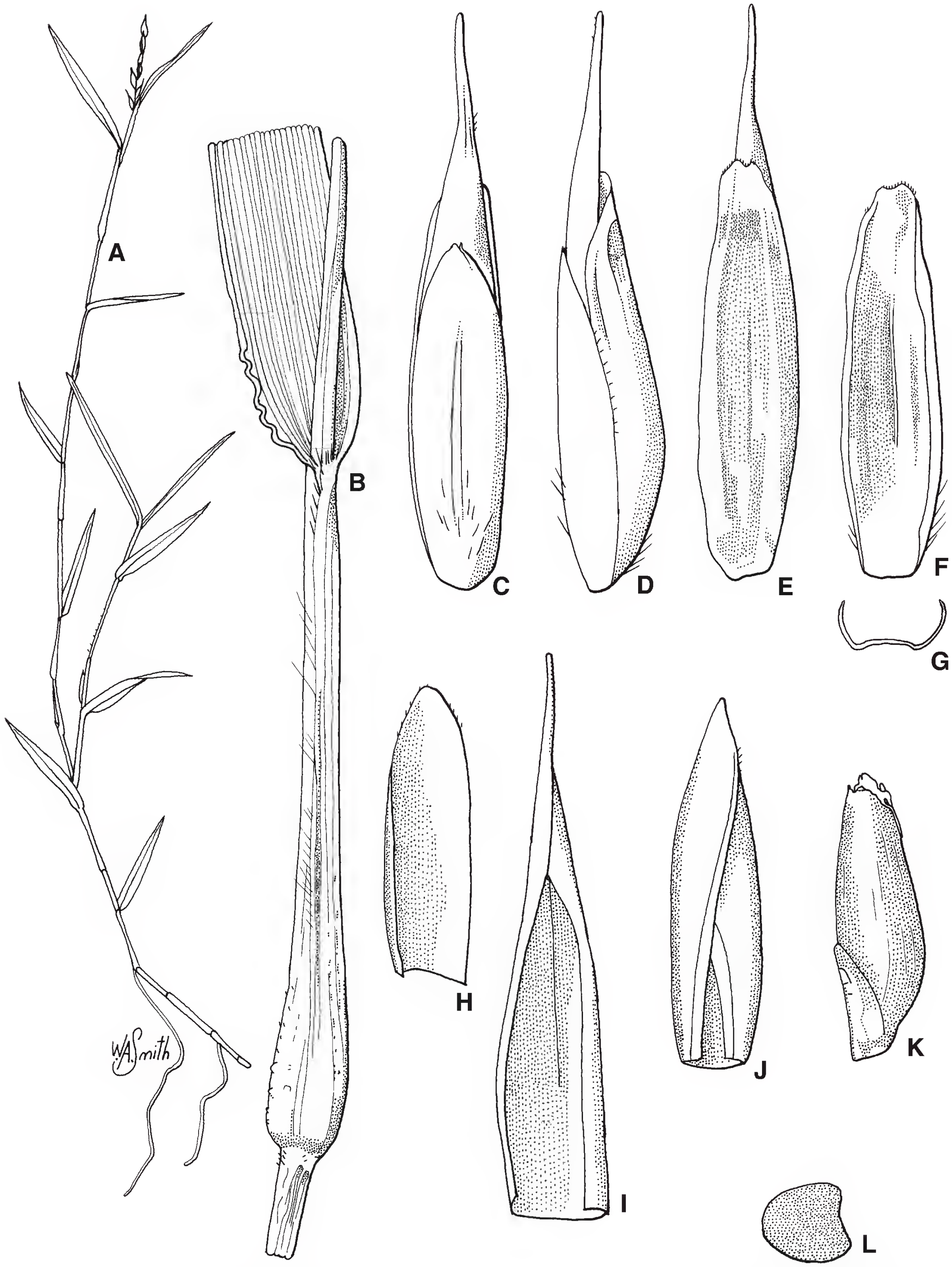

Fig. 3. Axillary spikelet of ***Calyptochloa gracillima*** subsp. ***ipsviciensis***. A. habit ×0.6. B. leaf sheath enclosing axillary spikelet ×8. C. upper glume facing ×16. D. side view ×16. E. lower lemma facing ×16. F. lower lemma ×16. G. cross-sectional view of lower lemma ×16. H. upper glume ×16. I. upper lemma ×16. J. upper palea ×16. K. caryopsis ×16. L. cross-sectional view of caryopsis ×16. A–L from *Thompson MOR689 & Simon* (BRI). Del. W.Smith

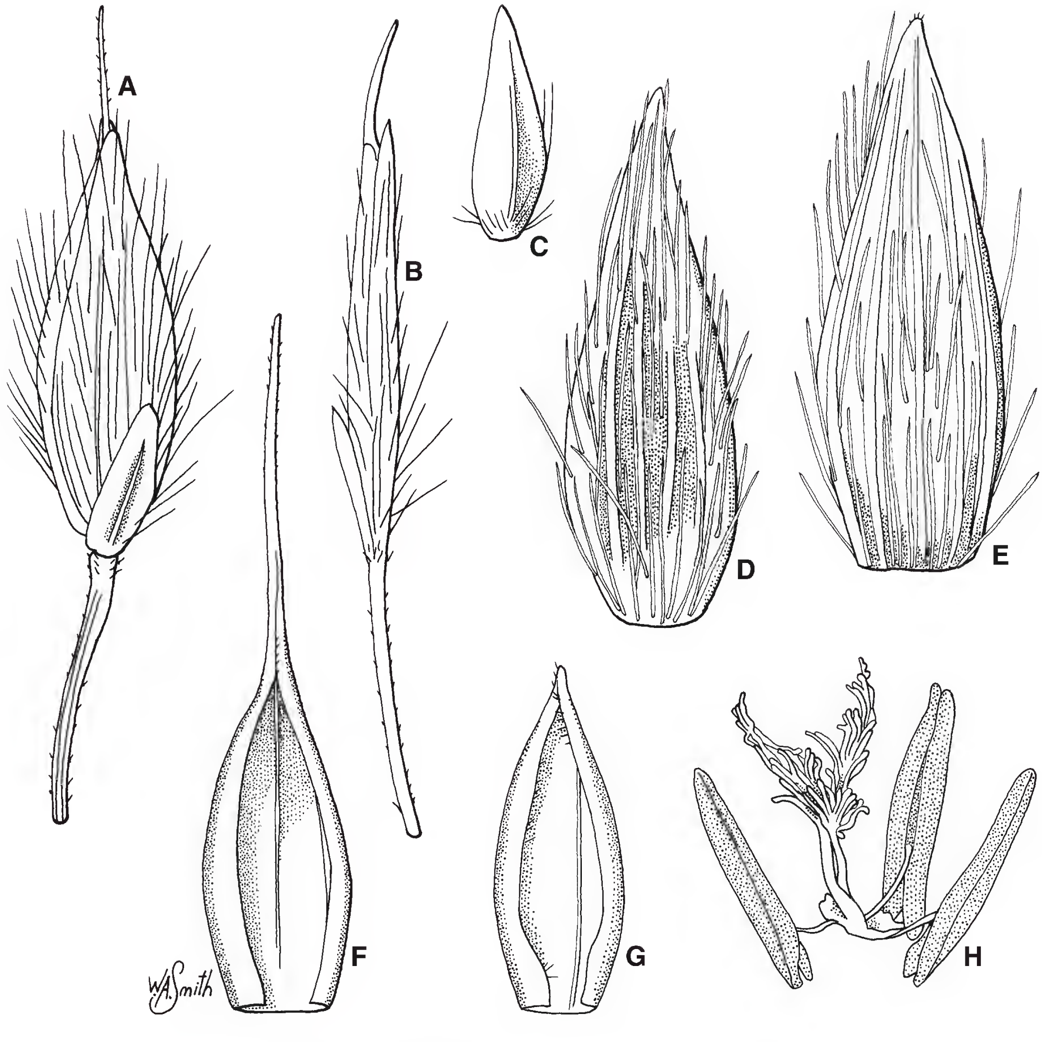

Fig. 4. Terminal spikelet of ***Calyptochloa gracillima*** subsp. ***ipsviciensis***. A. upper glume facing ×12. B. side view ×12. C. lower glume ×16. D. upper glume ×16. E. lower lemma ×16. F. upper lemma ×16. G. upper palea ×16. H. stamens and stigmas ×16. A–H from *Thompson MOR689 & Simon* (BRI). Del. W.Smith.

and *E. moluccana* Roxb. and/or *Corymbia citriodora* subsp. *variegata* (F.Muell.) A.R.Bean & M.W.McDonald on loam to clay loam duplex soils derived from shale on gently undulating to hilly terrain. REs represented include 12.9–10.2, 12.9–10.3 and 12.9–10.19. Associated ground layer species include *Aristida caput-medusae* Domin, *Cleistochloa subjuncea* C.E.Hubb. and *Themeda triandra* Forssk. The habitat is typically moderately shaded.

Phenology: *Calyptochloa gracillima* subsp. *ipsviciensis* flowers from December to March during the wet season. The cleistogamous spikelets are produced over a broader seasonal period.

Notes: Until 2011 there were no specimen records of *Calyptochloa gracillima* at BRI from the Moreton Pastoral District near Ipswich. These new records represent a disjunction of over 200 km from the previous known southern limit of the species.

Calyptochloa gracillima subsp. *ipsviciensis* is similar to *C. gracillima* subsp. *gracillima* in growth habit but on average it is taller, the mats cover a greater area and the leaves are more yellowish green. *C. gracillima* subsp. *ipsviciensis* also differs by the mostly thinner walled fertile leaf sheaths, and often the proportionally shorter fertile leaf sheath in relation to the internode length. Generally the fertile leaf sheaths cover about half the length of the culm internodes whereas for *C. gracillima* subsp. *gracillima* the leaf sheath usually covers most of the length of the culm internode. Only spikelets towards the apex of racemes of terminal inflorescences have a lower glume present, but it is often absent.

The distribution of this subspecies overlaps with *Ottochloa gracillima* C.E.Hubb. and *Entolasia marginata* (R.Br.) Hughes, both of which it could easily be confused with in the field in terms of growth habit and leaf colour and size although to date these species have not been seen growing with *C. gracillima*. *Ottochloa gracillima* and *Entolasia marginata* are distinguishable in the field by the branched inflorescences, the smaller glabrous spikelets and the abaxial leaf surface which is glabrous to sparsely hairy.

***Etymology*:** The subspecies epithet is derived in reference to the name of the nearby city of Ipswich where it has been found.

***Conservation status*:** *Calyptochloa gracillima* subsp. *ispviciensis* is only known from a few locations near the urban centre of Ipswich, two of which are Ipswich City Council reserves. At two locations only one or two plants or mats have been observed. The very restricted range and the few small populations suggest this subspecies should be considered **Critically Endangered** (criterion B1a,b [IUCN 2001]). Current threats include invasion from weeds such as *Megathyrsus maxima* var. *pubiglumis* (K.Schum.) B.K.Simon & S.W.L.Jacobs and *Lantana montevidensis* (Spreng.) Briq., inappropriate burning regimes, urbanisation and road construction.

2. Calyptochloa cylindrosperma E.J.Thomps. & B.K.Simon, **species nova** similar to *C. gracillima* C.E.Hubb. differing by the degree of swelling of the mature fertile leaf sheaths (slightly versus conspicuous) with thinner walls (0.2–0.3 mm versus 0.3–0.5 mm); the longer axillary spikelets (6–7.5 mm versus 3.5–5.5 mm) with longer caryopses (3.8–4 mm versus 2–3.7 mm) and shape (cylindrical versus plano-convex); the longer terminal spikelets (5–6 mm versus 3–5 mm) with longer anthers (2.5–2.6 mm versus 1.6–2 mm) and longer upper glume (5–6 mm versus 2.3–5 mm). **Typus:** Queensland. North Kennedy District: 16 km SW of Charters Towers on edge of road, 7.5 km W of Black Jack, 30 March 2011, *E.J.Thompson CHA769, B.K.Simon & M.Edginton* (holo: BRI; iso: CANB, K, L, MO, NSW, SI, US).

Calyptochloa sp. (Blackjack E.J.Thompson+ CHA769) (in BRI HERBRECS database accessed July 2012).

Decumbent stoloniferous perennial. Ascending branches to 40 cm tall, copiously branched with 10–30 nodes. Stolons to *c.* 0.5 m long. Mid-culm leaf blades 15–30 mm long, 2–4 mm wide; adaxial surface with scattered to moderately dense simple hairs to 0.5–1.6 mm long; abaxial surface with moderately dense simple hairs 1–2 mm long. Mature fertile leaf sheaths retained, semi-woody, 15–20 mm long, 1.2–1.7 mm wide near base with wall 0.2–0.3 mm thick; tubercle-based hairs 0.7–1.4 mm long between nerves, simple hairs absent; outer margin hairs to 1 mm long. Fertile culm internodes 20–45 mm long. Sterile leaf sheaths with scattered tubercle-based hairs 0.4–1 mm long and some simple hairs 0.5–2 mm long. Terminal inflorescences on axes 2–5 cm long, 5–10-flowered. Spikelets 5–6 mm long (without awn), 1.5–2 mm wide; lateral pedicels 0.5–1.5 mm long; ultimate pedicels 3–8 mm long; ultimate spikelets frequently longer than basal spikelets. Lower glume triangular, 0.1–0.5 mm long. Upper glume 5–6 mm long; apex acute. Lower lemma 5–6 mm long; apex acute. Upper lemma body 3–4 mm long, awn to 2.5–4 mm long. Lodicules *c.* 0.3 mm long. Upper palea 3–4 mm long. Anthers 2.5–2.6 mm long. Caryopsis not seen. Axillary inflorescences enclosed in leaf sheaths within scarcely enlarged basal portion usually present at 3–5 internodes. Spikelets 6–7.5 mm long (without awn), 0.7–0.9 mm wide. Upper glume 0.7–4.5 mm long, apex acute. Lower lemma 6–7.5 mm long. Upper floret subequal to lower. Upper lemma body 6–7.5 mm long, awn 1.5–2.5 mm long. Palea 5.5–6 mm long; acute to shortly awned. Anthers *c.* 0.6 mm long. Caryopsis cylindrical, 3.8–4 mm long, 0.5–0.6 mm wide. **Fig. 5 & 6.**

***Additional specimens examined* (c. 55 collections examined): Queensland.** North Kennedy District: near Charters Towers, Apr 1943, *Blake 14904* (BRI); 50 km NW of Charters Towers, Dec 2011, *Thompson CHA779* (BRI); 16 km SW of Charters Towers on edge of road, Mar 2011, *Thompson CHA767 et al.* (BRI); 16 km W of Charters Towers on edge of Capricorn Highway, Mar 2011, *Thompson CHA773 et al.* (BRI); 16 km SW of Charters Towers on road to Jesmond, Mar 2002, *Thompson CHA556 & Turpin* (BRI, CANB, RSA); 20 km SW of Charters Towers, May 2012, *Thompson CHA786 & Simon* (BRI, CANB, K); 15 km NE of Mt Cooper Homestead, Jun 1992, *Thompson CHA332 & Sharpe* (BRI); 88 km SE of Charters Towers, May 2012, *Thompson CHA801 & Simon* (BRI, CANB, K). South Kennedy District: (site plot 53) 8.5 km SW of Mt Hope Homestead, Apr 1992, *Thompson BUC508 & Simon* (BRI); Blackwood N.P., 160 km S of Charters Towers, Mar 1998, *Cumming 16888* (BRI); *ditto loc.*, Dec 2011, *Thompson CHA776* (BRI).

***Distribution and habitat*:** *Calyptochloa cylindrosperma* is known from central Queensland near Charters Towers (**Map 1**). It usually grows as the dominant ground cover, commonly in woodland of *Acacia shirleyi* Maiden, with or without *A. catenulata* C.T.White, on lateritic landscapes on mostly Tertiary plateaux with gently undulating red soil, occasionally jump-ups with shallow soils, or sometimes on shallow soils in sheltered gullies on quartzose sandstone. Associated ground layer species include *Cleistochloa subjuncea*, *Thyridolepis xerophila* and *Aristida caput-medusae*. Regional Ecosystems represented include 10.7.3a and b, and 11.7.2. The habitat is typically well shaded.

***Phenology*:** *Calyptochloa cylindrosperma* flowers from December to March during the wet season. Axillary spikelets are produced over a broader seasonal period.

***Notes*:** *Calyptochloa cylindrosperma* is similar to *C. gracillima* in growth habit (**Table 1**) and they have been found growing together at the transition of habitat from skeletal soil to deep red soil with the latter habitat occupied by *C. cylindrosperma*.

Only spikelets towards the apex of racemes of terminal inflorescences have a lower glume present; however, it is often absent.

Calyptochloa cylindrosperma also has an overlapping distribution and shares habitat with *Calyptochloa* sp. (Charters Towers E.J.Thompson+ CHA554). This latter species differs by the terminal spikelets having the upper glume and lower lemma convex in cross-section and the upper floret as long as the spikelet, and the axillary inflorescences consisting of two types, one with paired spikelets, sessile and pedicillate, the other a single sessile spikelet.

***Etymology*:** The specific epithet is from the Greek *cylindro-* (cylindrical) and *-sperma* (seed) in reference to the shape of the cleistogamous caryopses.

***Conservation status*:** *Calyptochloa cylindrosperma* is common at several locations in northern central Queensland but has a very restricted range with narrow habitat diversity. The small populations suggest this species should be considered as **Critically Endangered** (criterion B1a,b) (IUCN 2001).

3. Calyptochloa johnsoniana E.J.Thomps. & B.K.Simon, **species nova** similar to *C. gracillima* differing by the longer axillary spikelets (6–6.1 mm versus 3.5–5.5 mm) with a longer upper glume (>4.8 mm versus <4.5 mm); the fertile leaf sheaths (woody abaxially and chartaceous adaxially versus semi-woody to woody for the whole circumference); the fertile culm internodes (bowed adjacent to the spikelets and exserted from the leaf sheath versus culm retained within the leaf sheath); upper glume of the terminal spikelet (scabrid versus pilose). **Typus:** Queensland. Leichhardt District: Duaringa, December 1976, *R.W.Strickland s.n.* (holo: BRI [AQ670557]).

Decumbent stoloniferous perennial. Ascending branches to 90 cm tall, copiously branched with 10–20 nodes. Stolons to *c.* 0.5 m long. Mid-culm leaf blades 20–40 mm long, 3–4 mm wide; adaxial surface with scattered

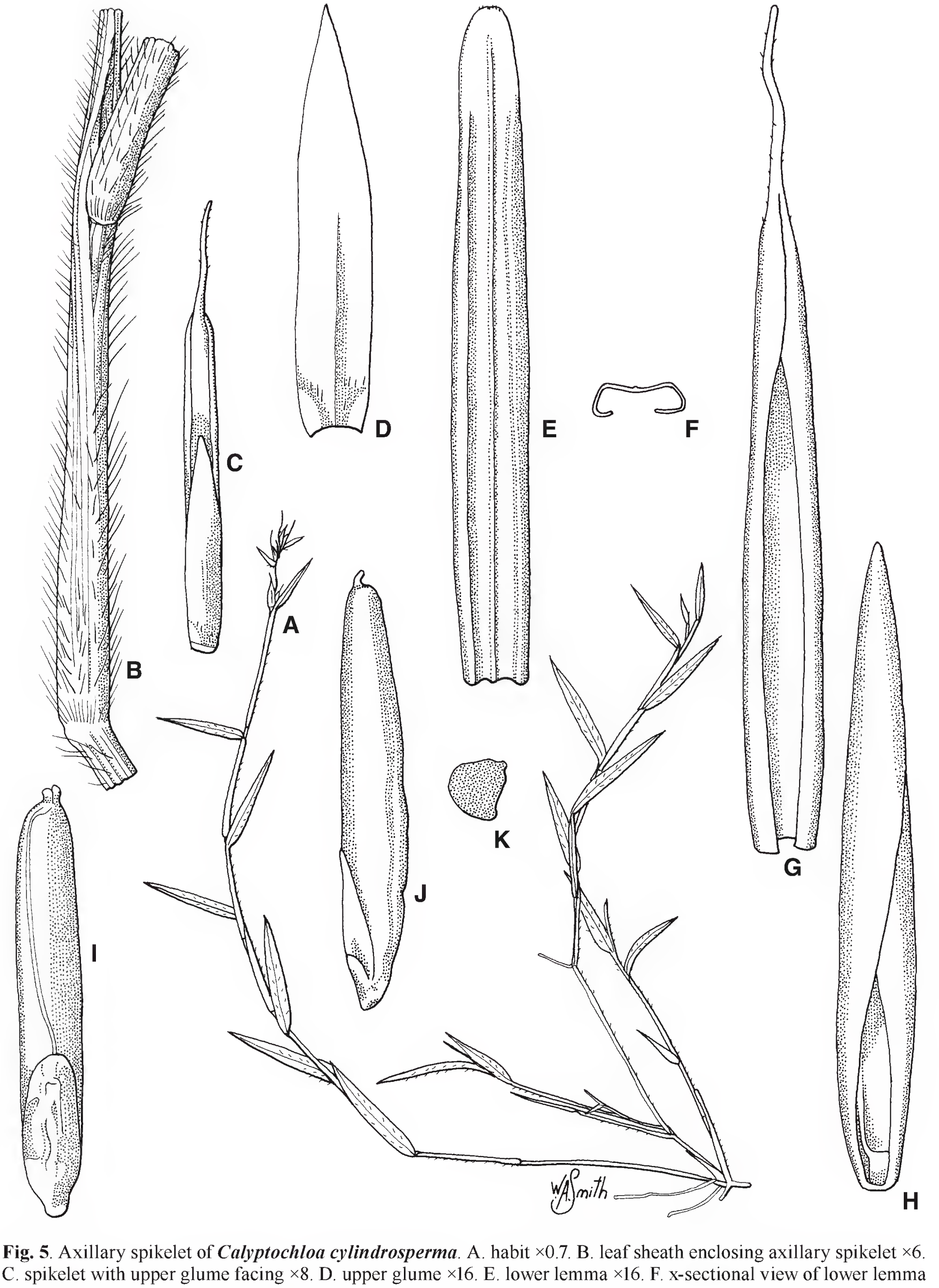

Fig. 5. Axillary spikelet of ***Calyptochloa cylindrosperma***. A. habit ×0.7. B. leaf sheath enclosing axillary spikelet ×6. C. spikelet with upper glume facing ×8. D. upper glume ×16. E. lower lemma ×16. F. x-sectional view of lower lemma ×16. G. upper lemma ×16. H. upper palea ×16. I. grain face view ×16. J. grain side view ×16. K. grain cross-sectional view ×16. A–K from *Thompson CHA767 et al.* (BRI). Del. W.Smith.

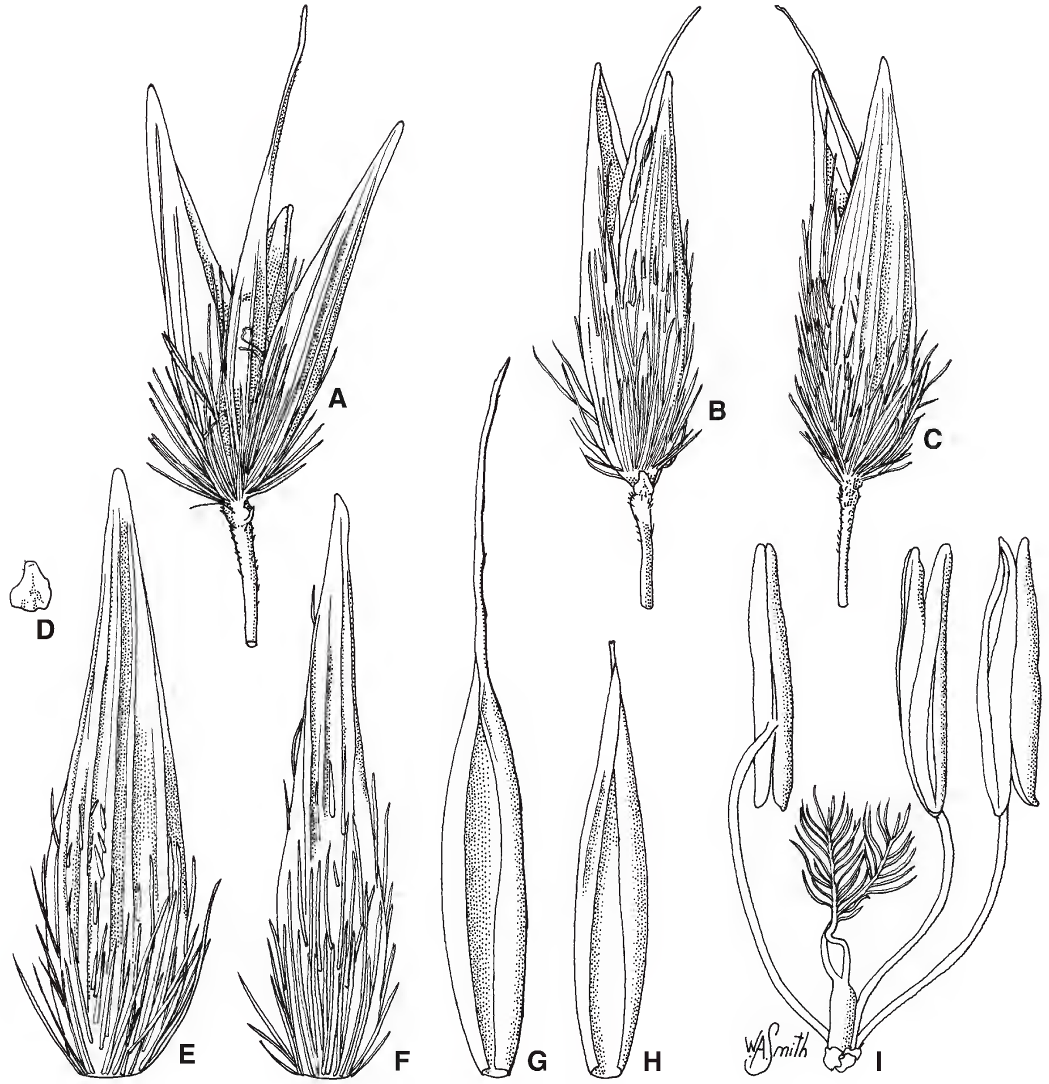

Fig. 6. Terminal spikelet of ***Calyptochloa cylindrosperma***. A. side view ×8. B. lower glume facing ×8. C. upper glume facing ×8. D. lower glume ×16. E. upper glume ×12. F. lower lemma ×12. G. upper lemma ×12. H. upper palea ×12. I. gynoecium and stamens ×16. A–I from *Thompson CHA767 et al.* (BRI). Del. W.Smith.

Table 1. Comparison of morphological characters for *Calyptochloa* taxa*

Character state		***C. cylindrosperma***	***C. gracillima* subsp. *gracillima***	***C. gracillima* subsp. *ipsviciensis***	***C. johnsoniana***
Terminal spikelets	Spikelet length × width (mm)	5-6 × 1.5–2	3–5 × 1.3–1.8	3–4.6 × 1.1–1.6	4.5–5.1 × 1.5–1.7
	Lower glume length (mm), apex shape	0.1–0.5, acute	<0.2, obtuse-truncate	0.8–1.8, acute	not observed
	Upper glume length (mm), apex shape	5–6, acute	3–5, obtuse to truncate	2.3–4.6, acute	4.5–5.1, truncate
	Lower lemma length (mm)	5–6	3–4.8	2.3–4.6	4.5–5.1
	Upper lemma length (mm)	3–4	3–3.5	2.2–3.2	3.1–3.5
	Upper lemma awn length (mm)	2.5–4	2–3	0.5–2.4	1–2
	Upper palea length (mm)	3–4	2.5–3	2–2.7	3–3.3
	Caryopsis length (mm)	not observed	2.3 (1.6–1.8*)	not observed	not observed
	Anther length (mm)	2.5–2.6	1.6–2 (0.5–1*)	*c.*1.5	*c.*1.6
Axillary spikelets	Spikelet length × width (mm)	6–7.5 × 0.7–0.9	4–5.5 × 1–1.1	3.5–4.2 × 0.8–0.9	6–6.1
	Upper glume length (mm)	0.7–4.5	0.5–1.5	0.7–3.5	4.8–5.1
	Upper lemma & lower lemma length (mm)	6–7.5	4–5.5	3.5–4.2	4–5
	Upper lemma awn length (mm)	1.5–3	2–2.6	0.5–2.5	*c.*4.5
	Upper palea length (mm)	5.5–6	3–3.8	2.7–3.5	4–4.5
	Caryopsis length × widthe (mm) shape	3.8–4 × 0.5–0.6, cylindrical	2–3.5 × 0.7–0.8, *c.* plano-convex	2.3–3.7 × 0.5–0.8, *c.* plano-convex	*c.* 4 × 1, cylindrical
	Anther length (mm)	*c.* 0.6	0.3–0.4	0.4–0.7	*c.* 0.3
	Width of mature fertile leaf sheath (mm)	1.2–1.4	1.5–2.7, mostly *c.* 2	1.2–2.5, mostly *c.* 1.5	*c.* 1.5
	Thickness of mature fertile leaf sheath at abaxial wall (mm)	0.2–0.3	0.3–0.5	0.3–0.4	*c.* 0.3

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* data from Hubbard (1933b)

simple and tubercle-based hairs 0.5–2 mm long; abaxial surface with scattered simple and tubercle-based hairs 0.5–2 mm long. Mature fertile leaf sheaths disarticulating, 10–20 mm long, *c.* 1.5 mm wide near base with wall to 0.3 mm thick on abaxial side, tapering to chartaceous margins; tubercle-based trichomes *c.* 0.5 mm long between nerves, simple hairs absent; outer margin hairs to 1 mm long. Fertile culm internodes, 13–20 mm long, protruding from leaf sheath and bowing around caryopsis. Sterile leaf sheaths with scattered tubercle-based hairs *c.* 0.3 mm long. Sterile culm internodes with medium density simple hairs to 2 mm long. Terminal inflorescences on axes 2–5 cm long, 5–6-flowered. Spikelets 4.5–5.5 mm long (without awn), 1.5–1.7 mm wide; lateral pedicels 0.3–1 mm long; ultimate pedicels 4–5 mm long. Lower glume not observed. Upper glume 4.5–5.1 mm long, body with simple hairs to 1.5 mm long at base and scabrid for 60% of length; margins with simple hairs to 2 mm long for 75% of length; apex truncate. Lower lemma 4.5–5.1 mm long, dense tubercle-based hairs to 2.5 mm long for 75% of length; apex obtuse. Upper lemma body 3.1–3.5 mm long, awn to 1–2 mm long. Lodicules *c.* 0.2 mm long. Upper palea 3–3.3 mm long. Anthers *c.* 1.6 mm long. Caryopsis not seen. Axillary inflorescences, spikelets single or rarely paired, one sessile and the other pedicellate, pedicel *c.* 6.5 mm long, enclosed within leaf sheaths with scarsely enlarged basal portion, usually present at 3–5 internodes. Spikelets 6–6.1 mm long (without awn), 1.4–1.5 mm wide. Upper glume 4.8–5.1 mm long, apex obtuse to truncate. Lower lemma 6–6.1 mm long. Upper floret *c.* 80% of length of lower. Upper lemma body 4–5 mm long, apex with two lateral lobes 0.3–0.5 mm long and awn 3–4.5 mm long. Palea 4–4.5 mm long. Anthers *c.* 0.3 mm long. Caryopsis cylindrical, *c.* 4 mm long and 1 mm wide. **Fig. 7 & 8.**

***Distribution and habitat*:** The species is known only from the type specimen collected from a red soil plateau near Duaringa (**Map 1**). The notes on the specimen label do not provide details about the habitat; however, from our existing knowledge it is very likely to be woodland dominated by *Acacia shirleyi* (RE 11.7.2).

***Phenology*:** Flowers in December and probably through to March during the wet season.

***Notes*:** *Calyptochloa johnsoniana* has an overlapping distribution and habitat with *C. gracillima* subsp. *gracillima* (**Table 1**) and *C.* sp. (Duaringa K.D. Addison 42). Because of the similar growth habit and leaves, *C. johnsoniana* could easily be confused in the field with *C.* sp. (Duaringa K.D. Addison 42) which differs by characters including the following: the scabrid ellipsoid cleistogamous spikelets, with woody upper glume and lower lemma, in axillary racemes; the terminal inflorescences being a reduced panicle; the terminal spikelets with upper glume and lower lemma having elliptical cross-section and upper floret equal to the spikelet length.

***Conservation status*:** This species is only known from a single specimen from the type locality near Duaringa. Pending the discovery of additional populations that may extend the geographical range, we recommend that this species should be considered **Critically Endangered** (criterion B1a-b [IUCN 2001]).

***Etymology*:** The specific epithet is in honour of Dr Robert W. Johnson (1930–2012), former Director at the Queensland Herbarium from 1976–1990.

Achnowledgements

We are very grateful to Dr. G.P. Guymer and A. Holland for their critical review of a draft of the manuscript, and Will Smith for the botanical illustrations and map. Many thanks to Steven Priday who first brought attention to the location of plants of the new subspecies at Ipswich, and David Moore for additional locations.

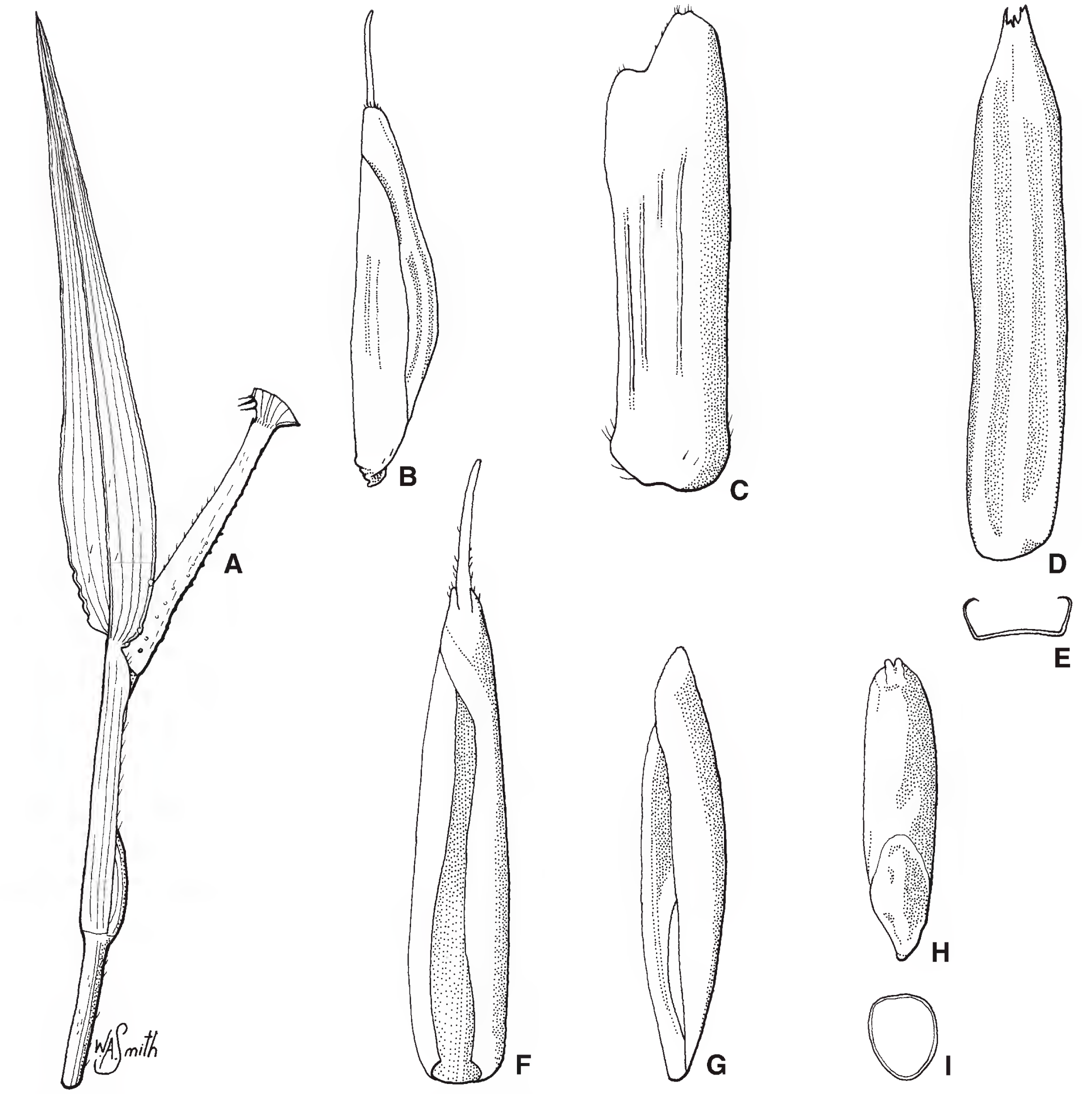

Fig. 7. Axillary spikelet of ***Calyptochloa johnsoniana***. A. leaf sheath enclosing spikelet ×3. B. side view ×8. C. upper glume ×12. D. lower lemma ×12. E. lower lemma ×12. F. upper lemma ×12. G. upper palea ×12. H. immature caryopsis ×12. I. cross-sectional view of immature caryopsis ×12. A–I from *Strickland s.n.* (BRI [AQ670557]). Del. W.Smith.

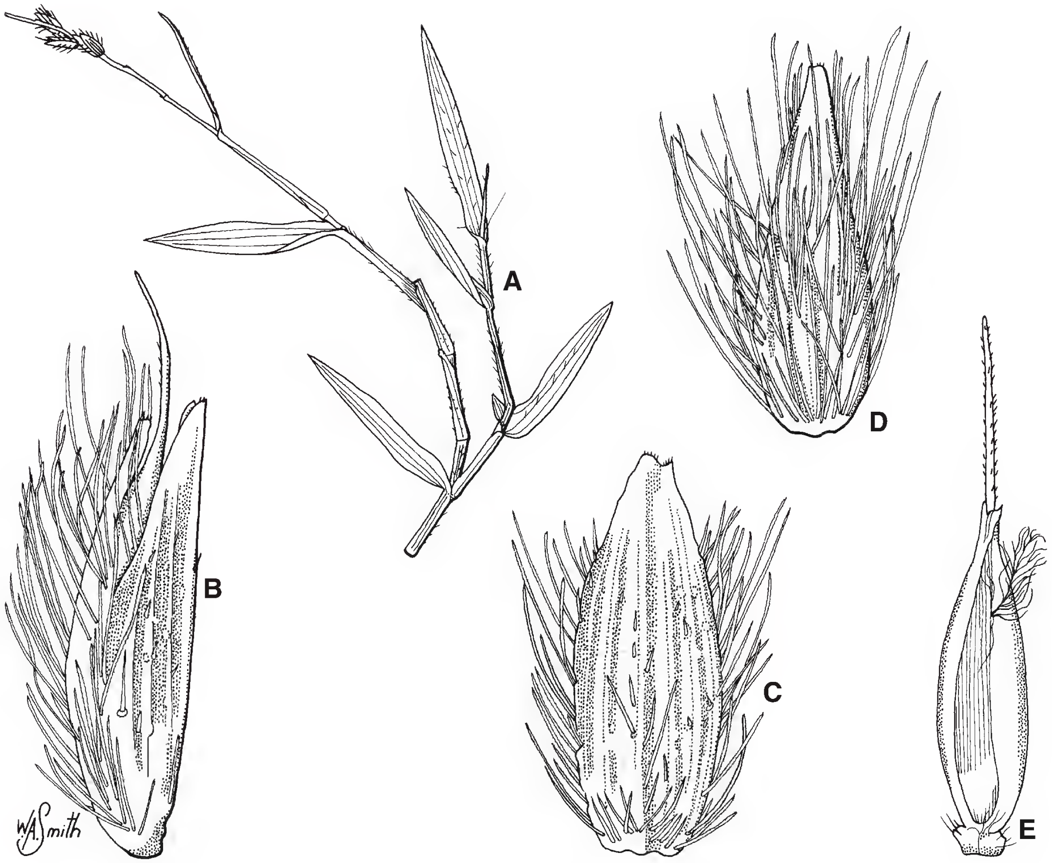

Fig. 8. Terminal spikelet of ***Calyptochloa johnsoniana***. A. portion of culm with terminal inflorescence ×1; B. side view ×12; C. upper glume ×12; D. lower lemma ×12; E. upper floret ×. A–E from *Strickland s.n.* (BRI [AQ670557]). Del. W.Smith.

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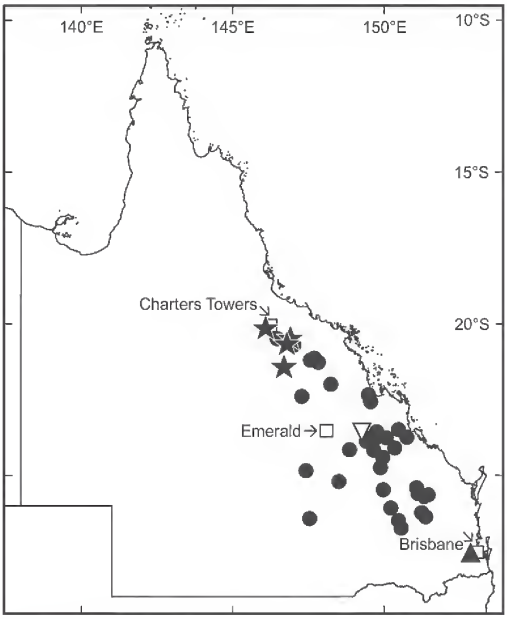

Map 1. Distribution of *Calyptochloa cylindrosperma* (★), *C. gracillima* subsp. *gracillima* (●), *C. gracillima* subsp. *ipsviciensis* (▲) and *C. johnsoniana* (▽)

The Australian species of *Blainvillea* ass. (Asteraceae: *Ecliptinae*)

A.E. Orchard

Summary

Orchard, A.E. (2012). The Australian species of *Blainvillea* Cass. (Asteraceae: *Ecliptinae*). ***Austrobaileya* 8(4): 653–669.** Characters separating the Australian species of *Blainvillea* from the closely related *Wedelia* are discussed. Four species are recognised in *Blainvillea*; these are keyed, described and illustrated (*Blainvillea acmella* (L.) Philipson, *B. calcicola* Orchard, sp. nov., *B. cunninghamii* (DC.) Orchard, comb. nov. and *B. gayana* Cass.). Of these, the first three are considered native, while *B. gayana* is a naturalised alien. Examination of extra-Australian specimens reveals that these four species account for the genus worldwide and a partial global synonymy is presented.

Key Words: Asteraceae, *Ecliptinae*, *Blainvillea*, *Blainvillea acmella*, *Blainvillea calcicola*, *Blainvillea cunninghamii*, *Blainvillea gayana*, Australia flora, taxonomy, new species, identification key

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Introduction

The pantropical genus *Blainvillea* Cass. comprises four species, although at various times as many as ten have been recognised (e.g. Bentham & Hooker 1873). It was described by Cassini (1823), with a single species, *B. rhomboidea* Cass. Other species were later described in *Blainvillea*, or transferred from genera such as *Verbesina* L., *Spilanthes* Jacq., *Eclipta* L. and *Wedelia* Jacq. For example, de Candolle (1836a) recognised five species, *B. rhomboidea*, *B. latifolia* (L.f.) DC. (based on *Eclipta latifolia* L.f.), *B. gayana* Cass., *B. prieuriana* DC. and *B. biaristata* DC. He also accepted (de Candolle 1836b) 34 *Wedelia* species, one of which (*W. cunninghamii* DC.) is here transferred to *Blainvillea*. Bentham (1867) recognised no *Blainvillea* species for Australia, although his "*Wedelia urticifolia*" was a misidentification of what is here accepted as *B. cunninghamii*.

The type species of *Blainvillea* was established when Koster & Philipson (1950) identified Cassini's *B. rhomboidea* as the species described by Linnaeus as *Verbesina acmella*, and by de Candolle as *Blainvillea latifolia*, and treated them all under the new combination *Blainvillea acmella* (L.) Philipson.

Specht (1958) described a new species of *Blainvillea* (*B. dubia* Specht) from Arnhem Land, the only one to that period with an Australian type, noting the difficulty in assigning it to *Blainvillea* versus *Wedelia*. More recently, the species *B. gayana* Cass., native to Africa, has been noted as locally naturalised near Mackay and Proserpine, Queensland. Other Queensland material has been tentatively identified as "*Moonia sp. Q1*", and "*Wedelia* sp. (Marrett River J.Elsol 680 & T.Stanley)". In the Northern Territory, some specimens have been assigned the temporary informal name *Wedelia* sp. Limestone (J.Russell-Smith 7865) N.T. Herbarium.

Generic circumscription of *Blainvillea*

Even a cursory examination of the synonymy of currently recognised taxa will reveal that taxonomists over the last nearly 200 years have struggled with generic delimitation in the *Wedelia* group of the subtribe *Ecliptinae* Less., with taxa moving between *Wedelia*, *Blainvillea*, *Eclipta*, *Wollastonia* DC. ex Decne., *Pentalepis* F.Muell., *Moonia* Arn. and *Pascalia* Ortega. *Pentalepis* is one of the more complex examples: Mueller (1863) described the genus *Pentalepis* with two species. Bentham (1867) treated them as *Moonia* in *Flora Australiensis*. They were subsequently transferred to *Chrysogonum* L. by Mueller (1882). Stuessy then reduced both

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Moonia (Stuessy 1975) and *Chrysogonum* (Stuessy 1977) to monospecific genera from India / Ceylon and the Americas respectively, referring the Australian species to "aff. *Blainvillea*". Lawrence (1992) recognised three Australian taxa in *Chrysogonum*, while Karis *et al*. (1993) resurrected *Pentalepis*, with three species). At various times *Wollastonia*, *Pentalepis* and *Pascalia* have been included in *Wedelia*, but are here and elsewhere (e.g. Panero 2007) considered distinct.

In preparing a treatment of *Blainvillea* for *Flora of Australia* it thus became necessary to first define the genus, particularly in respect to *Wedelia*. It should be noted that here and elsewhere in this paper the name *Wedelia* is used as currently accepted by many authors to include *W. spilanthoides* and about six related northern Australian taxa. The correct generic placement of these and related Malesian taxa will be the subject of a separate paper (in prep.). Unfortunately, there is no recent monograph covering either *Wedelia* or *Blainvillea*. Regional treatments such as Grierson (1980) use characters to separate the genera that work within their limited taxon range (in that case, floret colour), but have limited utility elsewhere. Within Australia, the dearth of northern Floras means that few attempts have been made to define the genera. Bailey (1900) used "Ray-florets with small ligules. Achenes not winged." (=*Blainvillea*) versus "Ray-florets with large yellow ligules. Achenes thick." (=*Wedelia*) as key characters, but he recognised only one species of *Blainvillea* and five of "*Wedelia*" (one of which is now *Wollastonia*). This limited coverage, plus the vague qualitative nature of his characters, makes them unsuitable for current purposes, where there are four species of *Blainvillea* and about six species of "*Wedelia*", plus *Wollastonia*. Ewart & Davies (1917) did not recognise *Blainvillea*, but one of their "*Wedelia*" species (*W. urticifolia*, treated here as *B. cunninghamii*) was distinguished from the rest by "Five or six of the outer involucral bracts more leaf-like and longer than the others" versus "Outer involucral bracts not longer than the inner ones" (= three species of "*Wedelia*" of which one is now *Wollastonia*). The only recent attempt to key these genera within Australia was that of Toelken (1983), who used the characters "Fruits curved; scales on receptacle folded" (=*Blainvillea*, one sp.) versus "Fruits straight; scales on receptacle chaffy" (="*Wedelia*", six spp., including *Wollastonia*). In a world-wide summary, Panero (2007) used the character "Cypselae with elaiosomes" (=*Wedelia*) versus "Cypselae without elaiosomes" (=*Blainvillea*) to key the two genera. Elaiosomes are present in many if not all core American *Wedelia* species, but not in Australian "*Wedelia*".

Examination of the Australian taxa; however, reveals a more useful set of characters, based on the paleae (receptacle bracts). In *Blainvillea* these are more or less oblong, truncate, laciniate and sometimes ciliate at the apex, scarious throughout (sometimes the central tooth greenish), and folded strongly around the florets (becoming flatter but still semi-clasping in fruit). In "*Wedelia*" the paleae are more or less lanceolate, tapering gradually to an acute apex, not laciniate, and green and fleshy in the upper part (scarious below). In Australian taxa of *Blainvillea* the number of ray florets is usually 2–5 (rarely 8) and disc florets 2–8, with about 4–6 (–16) achenes maturing per capitulum. In "*Wedelia*" the number of florets is usually much higher, resulting in broader more hemispherical to depressed globular capitula, appearing spiny from the rigidly erect palea tips.

Adoption of this set of characters means that *Wedelia cunninghamii* (mainly in the Northern Territory, but extending to Queensland and Western Australia) must be transferred to *Blainvillea*, where it is synonymous with (and the epithet pre-dates) *B. dubia*. The name *Wedelia urticifolia* has been misapplied to these plants (and sometimes to *B. acmella*) since Bentham (1867). Much material in herbaria of *B. cunninghamii* has in the past also been misidentified as *B. acmella* (syn. *B. latifolia*). *Blainvillea acmella* is present in Australia, but only in Torres Strait and a few near-coastal localities on Cape York Peninsula. *Wedelia urticifolia* does not occur in Australia. *Blainvillea gayana* is naturalised in a few localities in Queensland. Finally, a new species of *Blainvillea* (*B. calcicola*) is described from two small areas in the Northern Territory, making a total of four species (one naturalised, three native) of *Blainvillea* from Australia. These are described and illustrated below, and as they comprise the whole genus world-wide, a partial extra-Australian synonymy is provided.

The genus *Eisenmannia* Sch.Bip. (a generic synonym listed below) with a single species, *E. clandestina* Sch.Bip. was foreshadowed by Hochstetter (1841), but as a name only. The following year the species was relisted as a synonym of *Blainvillea gayana* (Schnizlein 1842: 135). A duplicate of the collection on which this invalid name was based is held in K (in agris Sorghi graminosis ad montem Cordofanum Arasch-Cool, 16 October 1839, *Kotschyi* iter Nubicum, K410220!, ex herb. Bentham). It is *B. acmella*.

Materials and methods

This paper arises from work undertaken to prepare a treatment of subtribe *Ecliptinae* (and other groups of the "Heliantheae alliance") for the *Flora of Australia*. It is based upon examination of all available material in the major Australian herbaria (AD, BRI, CANB, DNA, HO, MEL, NE, NSW, PERTH), plus some in BM, G, G-DC, K, L, and P. All specimens cited have been seen unless indicated *n.v.*

Common abbreviations used in the text include: N.P. (National Park), NT (Northern Territory), Qld (Queensland) and WA (Western Australia).

Taxonomy

Blainvillea Cass., *Dict. Sci. Nat.* 29: 493 (1823), after Henri M. Ducrotay de Blainville (1777–1850), professor of zoology, comparative anatomy and physiology, Paris.

Type: *Blainvillea rhomboidea* Cass. [=*B. acmella* (L.) Philipson]

Eisenmannia Hochst., *Flora* 24 (1, *Intelligenzbl.*): 42 (1841), *nom. inval.*, *nom. nud.*

Annual or perennial herbs with taproot; stems erect. Leaves opposite (sometimes becoming alternate near the inflorescence), simple, 3-veined, petiolate; base cuneate, apex acute; margins crenate to serrate. Capitula in leafy dichotomous cymes or openly paniculate, radiate or almost disciform; involucral bracts in 2 series; outer bracts usually green; inner bracts sometimes scarious; receptacle paleaceous; paleae scarious, oblong, truncate and laciniate (sometimes also ciliate) at apex, conduplicate, enclosing florets; ray florets female and fertile, with ligule minutely 2-(or 3-) lobed, yellow or white (mauve-white in *B. gayana*); disc florets bisexual and fertile, 5-merous, with corolla yellow or white; pappus of scales (often minute) and/or 1–several awns. Ray achenes 2 or 3 angled, usually dorsiventrally compressed, smooth to weakly rugose; disc achenes obpyramidal to obovoid, 2–4-angled, usually laterally compressed. Pappus of 0–5 awns, and/or with a few (usually very short), unequal, shortly connate scales.

A pantropical genus of four species. In Australia three native (one endemic) and one introduced. All occur in northern Australia.

The achenes of most species are very minutely wrinkled transversely under 10× magnification. These fine transverse wrinkles underlie any other rugosities.

Key to the species of *Blainvillea*

1 Achenes all ±subcylindrical (angled but not noticeably compressed), *c.* 5× as long as wide, awns 2–8, stiff, 1.5–3.5 mm long **2**
1. Achenes compressed, cuneate to obovoid, 2–2.5× as long as wide; awns 0–2, weak, 0.5–2.0 mm long **3**

2 Awns 2 (or 3), terete . . . . **1. B. gayana**
2. Awns 5–8, flattened (i.e. anatomically, lengthened slender scales) . . . . . . **2. B. calcicola**

3 Achenes convex at apex, 3–4 (–4.5) mm long, smooth, awns *c.* 0.5 mm long (if present) . . . . **3. B. cunninghamii**
3. Achenes truncate or sunken at apex, usually with raised corners at summit of angles, 4–5 mm long, weakly rugose; awns 1–1.3 mm long (if present). . . . . **4. B. acmella**

1. Blainvillea gayana Cass., *Dict. Sci. Nat.*, edn. 2, 47: 90 (1827). **Type citation:** "Senegal, *M.Gay*". **Type:** Jardin de Luxembourg, la 4 Septembre 1826. Sécher par Hardy en mon absence, des grains m'ont été envoyées de Richardtol (Senegal) sous le nom d' Ageratum? Bidens? Semer en Avril 1825 (holo: K 410221); iso: Blainvillea, cultivé au Luxembourg en 1826, les graines venant du Senegal, P 69616 (photo!); (see typification note below).

Blainvillea prieureana DC., *Prodr.* 5: 492 (1836). **Type citation:** "In Senegaliâ superiore ad montes Bakel legit cl. Leprieur (v.s. comm. à cl. inv.)". **Type:** Sénégambie, *s.dat.*, *Leprieur s.n.* (holo: G 23503, photo!).

Oligogyne burchellii Hook., *Icon. Pl.* 1: t. 101 (1837), *non Aspilia burchellii* Baker, *nec Wedelia burchellii* (Baker) B.Turner; *Calyptocarpus burchellii* (Hook.) Sch.Bip., *Bot. Zeitung (Berlin)* 24: 165 (1866). **Type citation:** "Rio Janeiro. Wm. J. Burchell, Esq. (n. 12)". **Type:** K, *n.v.*

***Illustrations*:** Hooker (1837: t. 101), as *Oligogyne burchellii*; Pacific Island Ecosystems at Risk (2011).

Erect annual herb to 2 m tall; stems softly pilose. Leaves opposite below, alternate above, broadly ovate to deltoid, becoming lanceolate in inflorescence, 30–120 mm long, 15–85 mm wide, shallowly crenate-serrate, pilose adaxially, more densely pilose abaxially, especially on veins; petioles 6–30 mm long. Capitula elongated-hemispherical, 10–12 mm diameter; involucral bracts lanceolate, subacute, green, pilose near apex, glabrous and striate below. Paleae oblong, stramineous, scarious, with laciniate apex, striate, glabrous except midrib. Ray florets 4–8; corolla mauve to white, *c.* 3 mm long; ligule 2-lobed. Disc florets 6–8; corolla white, *c.* 3.5 mm long. Achenes 6–16, narrowly cylindrical, brown to black, very finely transversely wrinkled, finely and sparsely pilose or subglabrous. Ray achenes subcylindrical, triquetrous, 4.5–5 mm long, slightly curved; pappus of 3 erect awns. Disc achenes subcylindrical, 2 or 3 angled, 5.5–6.5 mm long, ± straight; pappus of 2 (or 3) erect awns. Awns 1.5–2.5 mm long, antrorsely pilose, on a rostrum *c.* 0.5 mm long. **Fig. 1.**

***Additional selected specimens examined*: Africa (selection only): Cape Verde Islands:** *s. loc.*, 1895, *Cardosa s.n.* (K). **Ethiopia:** Abaye (Blue Nile) Gorge, Sep 1973, *Gilbert & Getachew 3089* (K). **Somalia:** 14 km on road between Luuq and Beled Xaawo, Jun 1989, *Thulin & Mohamed 6960* (K). **Djibouti:** between Djibouti and Arta, Apr 1993, *Collenette 8699* (K); **Cameroun:** Colline de Boboyo, Sep 1964, *Bounouge 97* (K). **Nigeria:** Panshanu Pass, Aug 1962, *Lawler & Hall 188* (K). **Kenya:** Marsabit N.P., Feb 2005, *Muasya NMK487 et al.* (K); **Tanzania:** Mkomazi Game Reserve, Apr 1995, *Abdallah & Vollesen 95/12* (K). **Senegal:** 20–23 km from Dendoudi, Oct 1988, *Lawesson 5307* (K). **The Gambia:** Yundum, Nov 1979, *Terry 3231* (K). **Ivory Coast:** Pronoi, Nov 1971, *Audrun 798* (K). **Botswana:** Ngamiland, Sennonore, Mann, Apr 1994, *Smith 5696* (CANB). **South America: Bolivia:** 57 km al S de Las Petas, May 2008, *Wood 24869 et al.* (K). **Brazil:** Brésil Méridional, 1838, *Guillemin 177* (K). **Australia: Queensland.** South Kennedy District: 35 km N of Mackay, Kuttabul, Brangus Court, Apr 2002, *Warren s.n.* (BRI); 6.7 km along Dingo Beach Road, N of Proserpine, Apr 2000, *Bean 16327* (BRI, K, NSW); Royston Park, property of Williamsons, W of Bruce Highway, *c.* 6 km N of township of Kuttabul, Apr 2002, *Warren 2* (BRI).

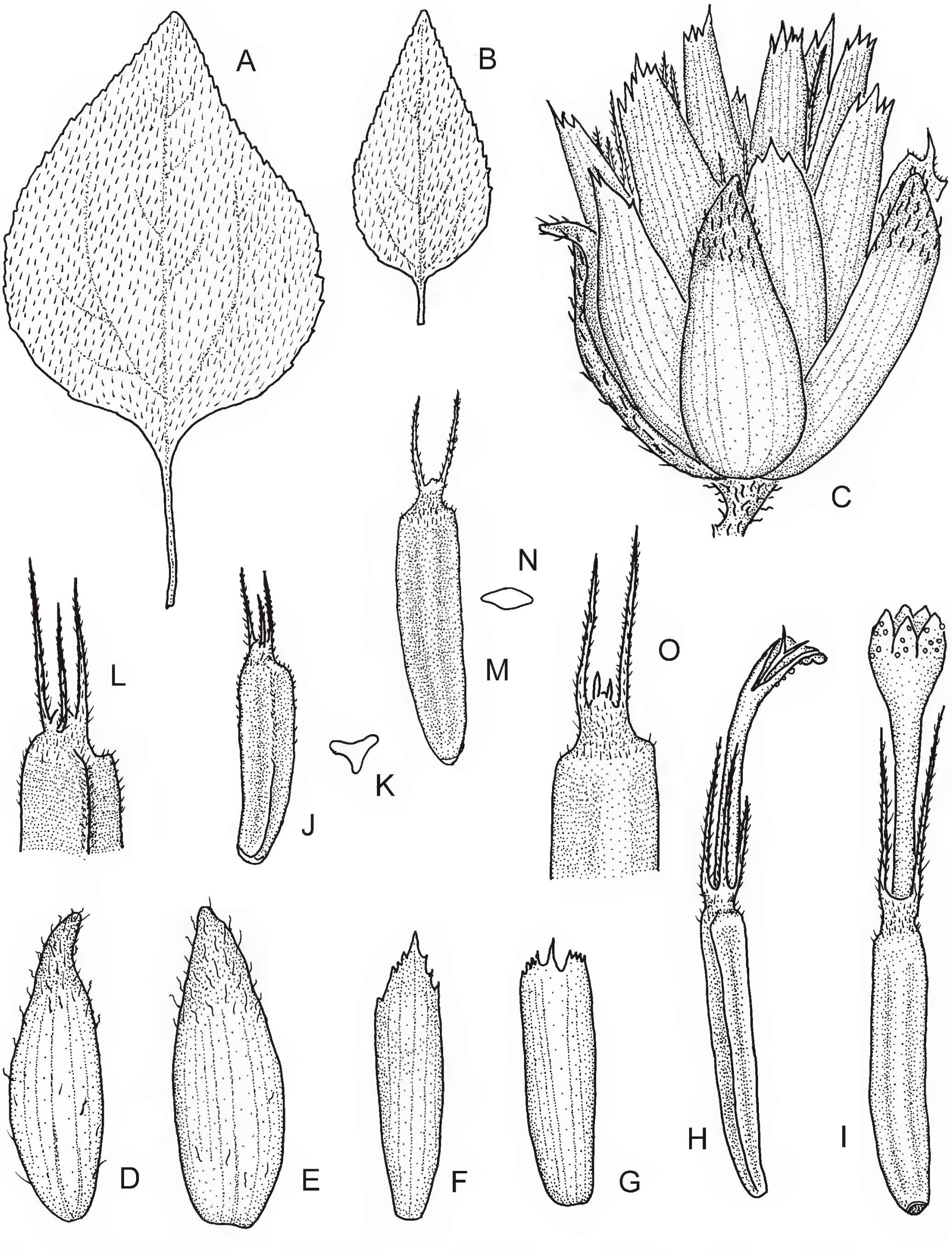

Fig. 1. ***Blainvillea gayana*****:** A. lower leaf ×0.6. B. upper leaf ×0.6. C. young fruiting capitulum ×6. D, E. involucral bracts ×6. F, G. paleae ×6. H. ray floret ×12. I. disc floret ×12. J. ray achene ×6. K. diagramatic transverse section of the ray achene shown as J. L. detail of summit of ray achene ×12. M. disc achene ×6. N. diagramatic transverse section of the disc achene shown as M. O. detail of summit of disc achene ×12. A–C, & J–O from *Bean 16327* (BRI), D–I from *Warren s.n.* (BRI [AQ555637]). Del. A.E.Orchard.

***Distribution and habitat*:** The species is a native of northern and tropical eastern, western and southern Africa (as far south as Botswana) where it is common in open areas. It is also known from the northern part of South America (e.g. Bolivia, Brazil) where it is possibly an introduction via the slave trade. In Australia (**Map 1**), several small infestations have been recorded in cleared land (remnant *Corymbia clarksoniana* (D.J.Carr & S.G.M.Carr) K.D.Hill, *C. tessellaris* (F.Muell.) K.D.Hill & L.A.S.Johnson and *E. platyphylla* F.Muell. woodland, on alluvial flats, stony gravels on hills, grassy cleared pastures) and adjacent to roadsides near Mackay and Proserpine, in North and South Kennedy districts of northern Queensland. While limited in distribution it can be locally abundant.

***Phenology*:** Flowers and fruits recorded in April.

***Typification*:** There are two specimens, one in Paris (P), the other in Kew (K), which seem to be type material for *Blainvillea gayana*. The one in Kew has attached to it a copy of the original printed description, with an annotation "Dict. des Sc. nat. tom. XLVII, publié le 23^e Mai 1827" (apparently not in Cassini's hand), an annotation in French of subsequent discoveries of the plant (apparently in Cassini's hand), and a copy of a letter, almost certainly to Gay, signed by Cassini, dated "Paris, ce 24 novembre 1826", in which he says "J'ai soigneusement examiné votre plante du Sénégal: ille apparient bien à mon genre Blainvillea; mais c'est indubitablement une nouvelle espéce, que ja vous demande la permission de nominer Bl. gayana, ...". It seems likely from this that the Kew specimen is the original material, that in Paris being a secondary duplicate (although labelled "Holotype"), and the K specimen is thus regarded here as the holotype, and that in P an isotype.

Although I have seen no authentic material of *Oligogyne burchellii*, from Hooker's plate there is no doubt that his plant is conspecific with *B. gayana*. This has been confirmed by N.Hind (K, *pers. comm.*).

***Notes*:** Easily distinguished from other Australian species of *Blainvillea* by its subcylindrical achenes with 2 or 3 long stiff awns. It is most likely to be confused with *B. acmella*, but differs in its capitula being narrower, particularly in flower (longer than broad), while those of *B. acmella* are usually broader than long. The awns on the achene of *B. gayana* are always straight and usually 2 mm or more long. Those of *B. acmella* are usually less than 2 mm and often curved and weaker. Its relationships, however, are probably with *B. calcicola*, with which it shares its long slender achenes.

2. Blainvillea calcicola Orchard **species nova**; resembling *B. cunninghamii*, but differing in having achenes which are cylindrical or barely compressed, *c.* 5.5 mm long, with 5 to 8 of the pappus scales greatly elongated (2–3.5 mm long) and serving as pseudo-awns. **Typus:** Northern Territory. Mathison Creek, Willeroo, 15 March 1989, *J.Russell-Smith 7865 & D.Lucas* (holo: DNA 42377; iso: BRI [AQ481744]).

Wedelia sp. Limestone (J. Russell-Smith 7865) N.T.Herbarium; Short *et al.* (2011: 19).

Erect annual herb (15–) 80–100 cm tall; stems softly pilose. Leaves all opposite, ovate, 45–70 mm long, 20–40 mm wide, shallowly crenate, moderate to densely, softly pilose adaxially, more densely pilose abaxially, especially on veins, with sessile golden glands between veins; petioles 15–20 mm long. Capitula obconical, 5–6 mm diameter; involucral bracts lanceolate, acute, green, densely pilose throughout. Paleae oblong, stramineous, scarious, with laciniate and ciliate apex, striate, with short appressed hairs and sessile golden glands dorsally. Ray florets 2 or 3; corolla yellow, 3–4 mm long; ligule 2 or 3-lobed. Disc florets 2 or 3; corolla yellow, 4–5 mm long. Achenes 4–6, grey, very finely transversely wrinkled, shortly pilose at apex and on angles. Ray achenes ±cylindrical (not noticeably compressed), *c.* 5.5 mm long, ±straight, minutely tuberculate; pappus of 5–8 erect to subpatent, flattened pilose scales 2–3.5 mm long. Disc achenes similar, but smooth, usually lacking tubercles. **Fig. 2**.

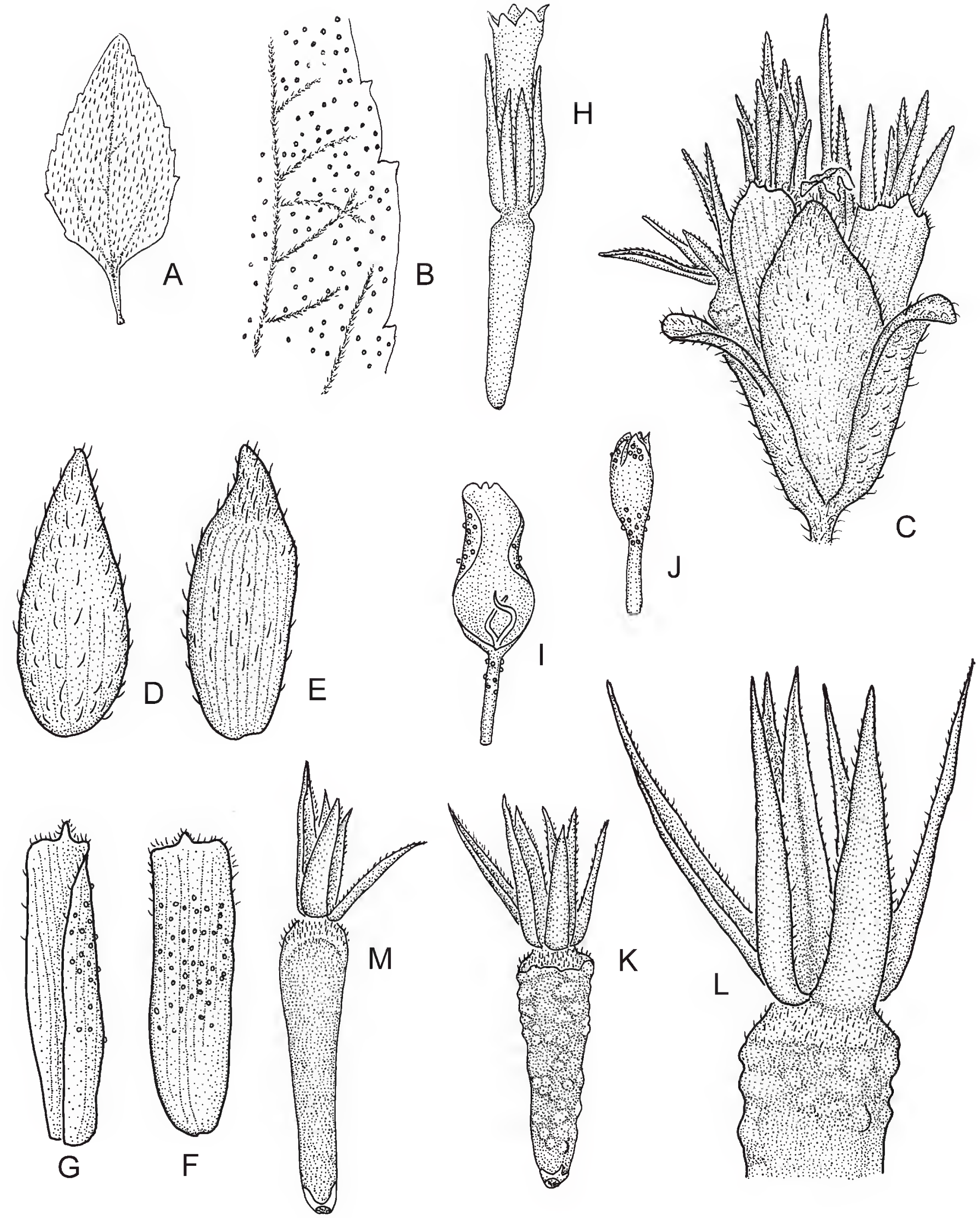

Fig. 2. ***Blainvillea calcicola*:** A. leaf ×0.6. B. leaf margin, abaxial view, showing hairs and glands (simplified) ×1.5. C. fruiting capitulum ×6. D, E. involucral bracts ×6. F. palea, dorsal view ×6. G. palea, lateral view ×6. H. disc floret ×6. I. corolla of ray floret ×6. J. corolla of young disc floret ×6. K. ray achene ×6. L. apical detail of ray achene ×12. M. disc achene ×6. All from *Russell-Smith 7865 & Lucas* (A–G, I, J from BRI; H, K–M from DNA). Del. A.E.Orchard.

***Additional specimens examined*:** **Northern Territory.** Mathison Creek, Willeroo, Mar 1989, *Dunlop 8318 & Leach* (DNA); Timber Creek, Mar 1998, *Michel 1246* (DNA).

***Distribution and habitat*:** *Blainvillea calcicola* is endemic to the Northern Territory, where it is found in vine thickets on karst, with *Celtis philippinensis* Blanco and *Trema tomentosa* (Roxb.) Hara, in a limited area near Willeroo and Timber Creek (**Map 2**).

***Phenology*:** Flowers and fruits present in March.

***Notes*:** In *Blainvillea calcicola* the scales at the apex of the achene are larger and perform the function of awns. It appears to be restricted to karst formations, but note that the superficially similar *B. cunninghamii* can also be found on this substrate. *Blainvillea cunninghamii* is distinguished, *inter alia*, by flattened achenes with pappus scales less than 0.5 mm long. The bodies of the achenes of *B. calcicola* are similar to those of *B. gayana*, but the latter has a pappus of 2 or 3 long stiff awns, not *c.* 7 long flattened scales.

3. Blainvillea cunninghamii (DC.) Orchard **comb. nov.**; *Wedelia cunninghamii* DC., *Prodr.* 5: 540 (1836). **Type citation:** "In rupestribus insularum Goulburn ad oram borealum Australiae, mart. flor. legit cl. A.Cunningham." **Type:** Australia: Northern Territory. Verbesina sp., grassy rocky spots, Goulburn Island, North Coast, March 1818, *[A.Cunningham] 59* (holo: G); Goulburn Island (1st Voyage of Mermaid), 1818, *A.Cunningham 184* (iso: BM 820301); Verbesina sp., grassy rocky spots, Goulburn Island, 28 March 1818, *A. Cunningham s.n.* (iso: K); (see typification note below).

Blainvillea dubia Specht, *Rec. Amer.-Austral. Sci. Exped. Arnhem Land, 3, Bot. Pl. Ecol.* 3: 314 (1958), **syn. nov. Type citation:** [N.T.] "South Bay, Bickerton Island (*Eucalyptus alba-E. polycarpa* woodland): 524. N. eg." **Type:** Australia: Northern Territory. South Bay, Bickerton Island, in the Gulf of Carpentaria (13° 45'S, 136° 6'E), 10 June 1948, *R.L.Specht 524* (holo: BRI; iso: AD 96149100, CANB 63749, K, L 1861, MEL 59399, NSW).

[*Wedelia urticifolia auct. non* DC.: Bentham (1867: 538); Bailey (1900: 861); Ewart & Davies (1917: 280)]

***Illustration*:** Specht (1958: 315, fig. 26), as *Blainvillea dubia*.

Erect aromatic annual herb (0.4–) 1–1.2 (–2) m tall; stems sparsely, softly pilose. Leaves all opposite, ovate (becoming narrower in inflorescence) 80–100 (–135) mm long, 35–50 (–90) mm wide, coarsely crenate, sparsely, softly pilose adaxially, sparsely pilose on veins abaxially with sparse sessile golden glands between veins; petioles 15–20 mm long. Capitula hemispherical, 3–5 mm diameter; involucral bracts lanceolate, acute, green, densely pilose throughout or in upper half, with inner bracts broader. Paleae oblong, stramineous, scarious, striate, with truncate laciniate and ciliate apex, glabrous dorsally or with sparse sessile golden glands. Ray florets 2 or 3; corolla yellow, *c.* 3.5 mm long; ligule 2-lobed. Disc florets 4–6; corolla yellow, *c.* 2.5 mm long. Achenes 5 or 6, grey to black, very finely transversely wrinkled, shortly pilose apically. Ray achenes obovoid-trigonous, compressed, 3–4 (–4.5) mm long, with apex convex, without raised corners at summit of angles, smooth (lacking tubercles), ±straight; pappus of minute (0.1–0.2 mm long) scales, sometimes with 1 or 2 extended as short soft "awns" *c.* 0.5 mm long. Disc achenes similar but 2-angled. **Fig. 3**.

***Additional selected specimens examined*:** **Western Australia.** Kalumburu Mission, May 1998, *Mitchell 5472* (DNA); 2.5 km N of Face Point, Carson Escarpment, Mar 1989, *Keighery 10666* (CANB, PERTH); Steep Head Island, Admiralty Gulf, Apr 2006, *Mitchell 8570* (CANB). **Northern Territory.** Stuart Highway, *c.* 11 miles [*c.* 18 km] SE of Katherine, Apr 1964, *Adams 932* (BRI, CANB, K, L, NSW, NT); headwaters of the Liverpool River, Apr 1984, *Craven & Wightman 8353* (CANB, DNA, MEL); Rocky Bay, Yirrkala, Mar 1988, *Russell-Smith 5170 & Lucas* (BRI, DNA); Waterfall Creek, Apr 1984, *Wightman 1281 & Dunlop* (BRI, CANB, DNA). **Queensland.** COOK DISTRICT: Lakefield N.P., 1.6 km S of mouth of North Kennedy River, Apr 1992, *Neldner 3775 & Clarkson* (DNA); Stanley Island, May 1995, *Le Cussan 539* (BRI).

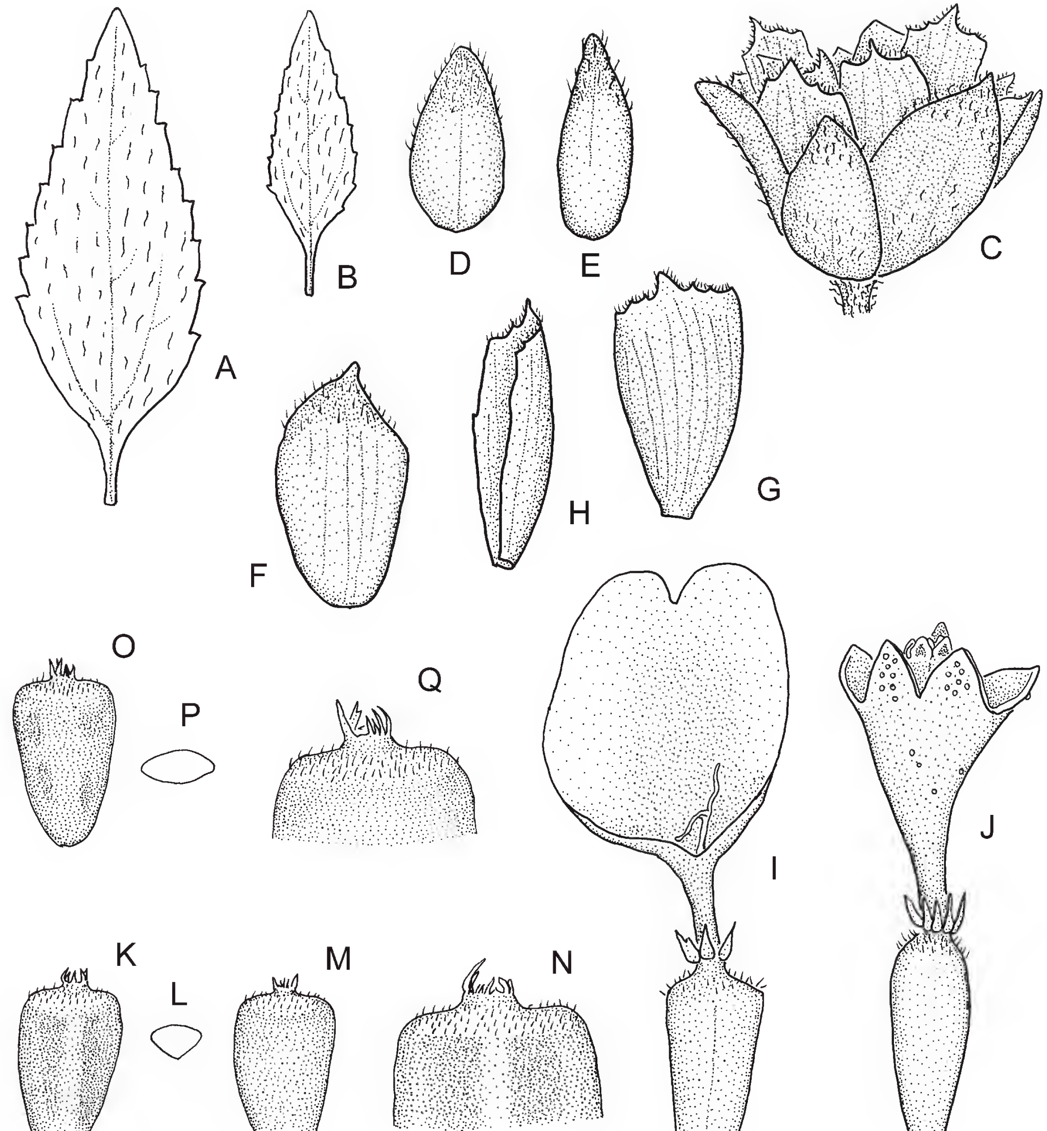

Fig. 3. ***Blainvillea cunninghamii*:** A. midstem leaf ×0.6. B. upper leaf ×0.6. C. capitulum ×6. D, E. outer involucral bracts ×6. F. inner involucral bract ×6. G. palea, dorsal view ×6. H. palea, lateral view ×6. I. ray floret ×12. J. disc floret ×12. K. adaxial view of ray achene ×6. L. diagramatic transverse section of K. M. abaxial (dorsal) view of ray achene ×6. N. apical detail of ray achene ×12. O. disc achene ×6. P. diagramatic transverse section of disc achene. Q. apical detail of disc achene ×12. A–H, K–Q, from *Wightman 1281 & Dunlop* (BRI); figures I, J from *Craven & Wightman 8353* (MEL). Del. A.E.Orchard.

Distribution and habitat**:** *Blainvillea cunninghamii* is native to northern Australia, from near Kalumburu Mission in WA, across the NT north of about Katherine, to mainly inland Cape York Peninsula in Qld, on sandy and loamy soils, in grassland, woodland understorey and the margins of vine thickets and rainforest, from sea level to less than 200 m in NT, but usually at 350–550 m in Qld (**Map 3**).

Phenology**:** Flowers present (Aug.–) Jan.–May (–June), fruits (Jan.–) Mar.–June (–July).

Typification**:** The holotype of *Wedelia cunninghamii* in G is numbered 59, while an apparent duplicate in BM is numbered 184, and another in K is unnumbered. The numbers applied to his specimens by Allan Cunningham are consignment list numbers, rather than unique collection numbers as currently understood. The number "184" was the consignment list number when the specimen was sent from Cunningham to Banks and Aiton from Sydney in 1818, while "59" was the consignment list number when he sent replicate material to Candolle from London in 1834. It seems that when he sent duplicates of his Australian collections to de Candolle in 1834, Cunningham renumbered them in a new list. Unfortunately this consignment list has not been located. However, Cunningham only collected this taxon once from Goulburn Island, so despite the difference in numbers, the G, K and BM specimens should be treated as replicates. A detailed account of Cunningham's numbering system and the disposal of his collections will be published elsewhere (Orchard, several papers in prep.).

Notes**:** This is the plant collected as "Buphthalmum acuminatum" by R.Brown at Morgan's Island, Blue Mud Bay, on 20 Jan. 1803 (BM, NSW), and later by A.Cunningham at South Goulburn Island in March 1818 (BM, G, K). Its presence in Australia thus almost certainly predates European settlement, and it is here considered native. Bentham (1867) treated the Brown and Cunningham specimens as *Wedelia urticifolia* DC., an Asian/Malesian species, and in this he was followed by Bailey (1900), Ewart & Davies (1917) and some later authors. *Wedelia urticifolia* has paleae which are rigid, lanceolate, with an acuminate, very acute or acicular apex (Backer & Bakhuizen van den Brink 1965), not truncate and laciniate as in *Blainvillea*. True *Wedelia urticifolia* has not been collected in Australia, although it is present in southern Indonesia.

Blainvillea cunninghamii is most similar to, and likely most closely related to, the predominantly Indian / Sri Lankan distributed *B. acmella*. Evolution of the former from the latter by genetic drift, from an isolated introduction to Australia at a remote time is not inconceivable. The current presence of *B. acmella* in Australia is almost certainly a recent event.

Plants growing in very damp shaded positions have larger leaves and capitula, and achenes to 4.5 mm long.

4. Blainvillea acmella (L.) Philipson, *Blumea* 6: 350 (1950); *Verbesina acmella* L., *Sp. Pl.* 2: 901 (1753); *Spilanthes acmella* (L.) Murray, *Syst. Veg.* 731 (1784); *Ceratocephalus acmella* (L.) Kuntze, *Revis. Gen. Pl.* 1: 326 (1891). **Type:** Habitat in Zeylona (lecto: Herb. Hermann 2: 10, No. 309, BM 594573, photo!), *fide* Koster & Philipson (1950: 349).

?*Verbesina dichotoma* Murray, *Comment. Soc. Regiae Sci. Gott.* 2: 15, Pl. 4 (1780), *nom. rej. prop.*; *Blainvillea dichotoma* (Murray) Hemsl., *Biol. Cent.-Amer., Bot.* 4: 112 (1887). **Type citation:** "[Hortus Regiae Goettingen] Floruit medio et exeunte m. Augusto in vaporario..." **Type:** *n.v.*, probably not preserved. See note below.

Eclipta latifolia L.f., *Supp. Pl.* 378 (1782); *Blainvillea latifolia* (L.f.) DC. in R.Wight, *Contr. Bot. India* 17 (1834). **Type citation:** "Habitat in India orientali." **Type:** *n.v.*

Verbesina lavenia Roxb., *Hort. Bengal.* 62 (1814), & Roxb., *Fl. Ind.* 3: 442 (1832), *nom. illeg., non V. lavenia* L., *Sp. Pl.* 2: 902 (1753) [=*Adenostemma lavenia* (L.) Kuntze].

?*Blainvillea rhomboidea* Cass., *Dict. Sci. Nat.* 2nd edn, 29: 493 (1823), *nom. rej. prop.* **Type citation:** "Cultivés au Jardin du Roi, où ils fleurissent vers le milieu du mois de septembre." **Type:** Blainvillea rhomboidea

H.Cass. [scripsit Cassini] H.P.Coucher [Hortus Parisiense Grown], 15 October 1817, Herb. J.Gay (holo: *n.v.* ?P; iso: K 487624 [Presented by Dr Hooker, February 1868]). See note below.

Verbesina dichotoma Wall., *Numer. List* [*Cat.*] 3204A (in part), B, C, D, E (1831), *nom. nud.*, & *nom. illeg.*, *non V. dichotoma* Murray. Based on [India], 1849, *Wallich herb. no. H.9. 3204 H*, K, ex herb. Bentham.

Blainvillea alba Edgew., *Trans. Linn. Soc.* 20: 70 (1846). **Type citation:** [N.W. India] ”Pinjar Dhún, in arvis, Prov. Sirhind, Indiae Bor.-Occ. Sept.” **Type:** India. Pinjar Dhùn [sic] in arvis, 1844, *M.P.Edgeworth s.n.* (holo: K, ex herb. Bentham).

Blainvillea hispida Edgew., *Trans. Linn. Soc.* 20: 70 (1846). **Type citation:** [N.W.India] ”Himala, in arvis, alt. ped. 4000–5000, Junio.” **Type:** India. Himalaya in arvis, altit. 4–5000 ped., 1844, *M.P.Edgeworth s.n.* (holo: K, ex herb. Bentham).

Wedelia sp. (Marrett River J.A.Elsol+ 680); Holland (1997: 34).

***Illustrations*:** Bailey (1906: 86); Koster & Philipson (1950: 350, fig. 1); Matthew (1982: Pl. 356); Hajra *et al.* (1993: 378, fig. 101).

Erect annual aromatic herb (0.6–) 1.2–1.5 m tall; stems hispid with sparse hairs swollen at base. Leaves opposite below, alternate above, ovate to lanceolate, 80–100 mm long, (35–) 40–50 mm wide, coarsely crenate, adaxially sparsely scabrid, abaxially densely scabrid especially on veins, with coarse white hairs swollen at base, and sessile golden glands between veins; petioles 15–20 mm long. Capitula hemispherical, 6–10 mm diameter; involucral bracts lanceolate to linear-lanceolate, acute, green, densely hispid throughout; inner bracts ovate, acute to acuminate, green above, stramineous below. Paleae oblong, stramineous, scarious, with laciniate and sparsely ciliate apex, striate, shortly pilose dorsally with numerous sessile golden glands. Ray florets 4–6; corolla yellow, *c.* 3 mm long; ligule 2-lobed. Discs florets 5–7; corolla yellow, *c.* 2 mm long. Achenes 6–10, grey to black, shortly pilose in upper half. Ray achenes cylindrical-trigonous, somewhat compressed, 4–5 mm long, often slightly curved, apically truncate or sunken, the angles crowned by short peaks, weakly rugose; pappus of very short scales (sometimes absent), usually with 1 or 2 short awns 1–1.3 mm long. Disc achenes obovoid, 2-angled, compressed, 5–6 mm long, smooth apart from fine transverse wrinkles; pappus as ray achenes. **Fig. 4**.

***Additional selected specimens examined*:** **Africa: South Sudan:** Tokar Delta, Apr 1949, *Bally 6978* (K). **Sudan:** (Nubia) Mt Cordafanum Arash-Cool, Oct 1839, *Kotschy s.n.* (K, ex herb. Bentham). **India:** Madras, Hatiguda, Feb 1884, *Gamble 13801* (K); Andhara Pradesh, Khammam district, Oct 1988, *Seethapathi Rao s.n.* (K); Bangalore, Nandi Hills road, Jan 1973, *Burtt RHT18356 et al.* (K); Salem, Servarayans, Nov 1978, *Venugopal & Jayaseelan RHT18781* (K); Jashpur, Dumarkona, Sep 1941, *Mooney 1860* (K). **Sri Lanka**: Ceylon, 1848, *Gardner 602* (K, ex herb. Bentham); Polonnaruwa, near Recumbent Buddah statue, Feb 1969, *Grierson 1026* (CANB). **Australia: Western Australia.** eastern margin of Mitchell Plateau, Apr 1991, *Willing 335* (PERTH). **Queensland.** COOK DISTRICT: Mabuiag, Torres Strait, 13 Apr. 2000, *Waterhouse 5847* (BRI, CANB); Thursday Island, May 1893, *Cowley s.n.* (BRI); Albany Island, May 1995, *Le Cussan 435* (BRI); Cape York, *s.d.* [*c.* 1866], *Daemal s.n.* (MEL); Roko Island, Feb 2002, *Waterhouse 6351* (BRI, CANB, US); Marrett River, Princess Charlotte Bay, May 1979, *Esol 680 & Stanley* (BRI); Pickford Road, Biboohra, Mar 2000, *Clayton s.n.* (BRI, K).

***Distribution and habitat*:** The species is native to India and Sri Lanka with occasional records from Africa (Sudan, possibly elsewhere), probably representing introductions. It has been reported from China (Chowdhery 1995) but no specimens from there were seen during this study. Literature records for the Americas are mainly misidentifications of *B. gayana* although those from the Galápagos Islands are *B. acmella*. In Australia (**Map 4**), it is widespread in the islands of Torres Strait, and occasional in coastal localities mainly on northern Cape York Peninsula, with occasional occurrences further south. A single collection from Mitchell Plateau, WA, may represent an introduction. Plants are usually found in near-coastal localities near sea level, often on alkaline soils (coral cays, beach sand, shell banks), sometimes extending into the understorey of woodland and vine thickets.

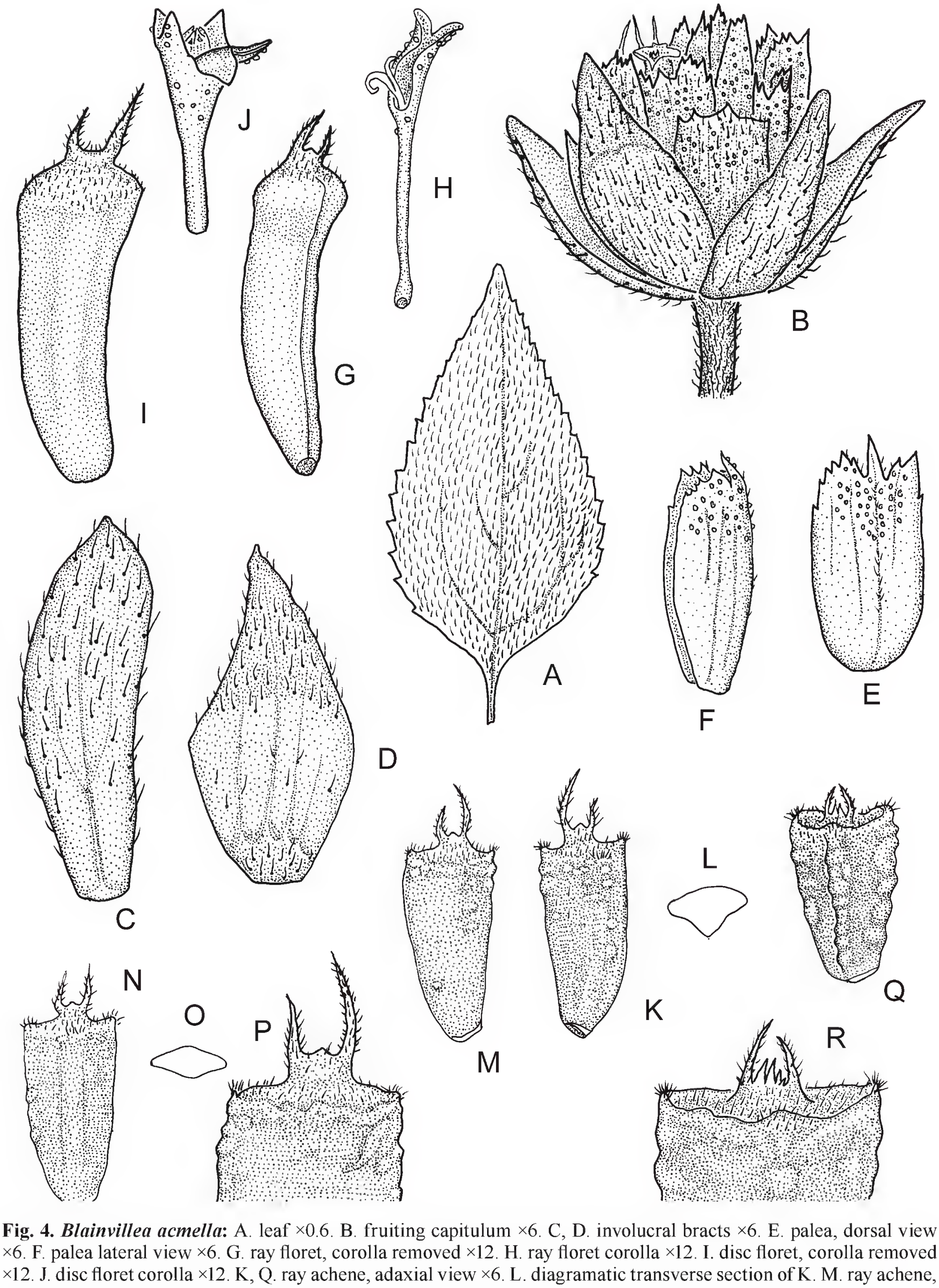

Fig. 4. ***Blainvillea acmella*:** A. leaf ×0.6. B. fruiting capitulum ×6. C, D. involucral bracts ×6. E. palea, dorsal view ×6. F. palea lateral view ×6. G. ray floret, corolla removed ×12. H. ray floret corolla ×12. I. disc floret, corolla removed ×12. J. disc floret corolla ×12. K, Q. ray achene, adaxial view ×6. L. diagramatic transverse section of K. M. ray achene, abaxial (dorsal) view ×6. N. disc achene ×6. O. diagramatic transverse section of N. P. apical detail of ray achene ×12. R. apical detail of ray achene Q ×12. A–P from *Clayton s.n.* (BRI [AQ490047]); Q, R from *Le Cussan 435* (BRI). Del. A.E.Orchard.

Phenology**:** Flowers recorded in February to July, fruits in March to July.

Typification**:** The name *Verbesina dichotoma* Murray was based on material grown in the Royal Garden at Goettingen and no surviving authentic specimen has been located. Murray's description and plate are somewhat ambiguous, but on balance, the illustration of rather broad capitula, and the description and illustration of the achenes as relatively broad with rather short awns, suggests that Murray's plant was *B. acmella* rather than *B. gayana*. However, because this name would have priority over *B. gayana* if proven to be conspecific, it is being proposed for rejection against that name in a separate paper.

The combination *Blainvillea dichotoma* has been made at least twice. Hemsley (1887) first made the combination, for Galápagos Island plants, with the cryptic listing of "Blainvillea dichotoma, Cass." This is an indirect reference to Cassini (1829) in which the combination is implied but not actually made, with the observation "Blainvillea. = An? Verbesina dichotoma, Moench (1794)." Moench (1794) lists *Verbesina dichotoma*, attributing it to Murray. The correct author attribution is therefore *Blainvillea dichotoma* (Murray) Hemsl. Stewart (1911) listed Hemsley's combination as "B[lainvillea] dichotoma (Murr.) Cass. acc. to Hemsl. Biolog. Cent.-Am.Bot. IV. 112 (1886–1888)", citing *Verbesina dichotoma* Murray, *Comment. Soc. Regiae Sci. Gott.* 2: 15, Pl. 4 (1780), as basionym, and *B. rhomboidea* Cass. as a synonym. Later authors (e.g. Wiggins & Porter 1971; McMullen 1999; Jørgensen & León-Yánez 1999) have attributed the combination as *Blainvillea dichotoma* (Murray) Stewart, which is incorrect. From the descriptions and illustrations in these works, the Galápagos plants are *B. acmella* rather than *B. gayana*. IPNI also lists "*Blainvillea dichotoma* Luetzelb., *Estud. Bot. Nordeste i. (Publ. Insp. Fed. Obras Contr. Secc., Rio de Janeiro,No. 57, Ser. I.A.)* 41 (1922–3), nomen". It is not clear whether this *nomen nudum* was in fact an attempt at a new combination or merely usage of Hemsley's combination.

Blainvillea rhomboidea was described from plants cultivated in the Royal Botanic Garden, Paris, from seed of unstated origin. I have seen no specimens from the Paris herbarium which could be considered to be type material, but in Kew there is a sheet with a printed label "Herb. J.Gay. Presented by Dr. Hooker, February 1868." and annotated by Cassini "Blainvillea rhomboidea, H. Cass." and "H[ortus]. P[arisiense]. Coucher. 15^{e} Octobre 1817." This is here described as an isotype, but may in fact be the holotype. It has capitula with somewhat immature achenes. The achenes are somewhat intermediate between what is here accepted as *B. acmella* and *B. gayana*, but the few more mature ones are rugose and proportionately broad, and these, plus the broad hemispherical capitula suggest placement with *B. acmella*, as suggested by Koster & Philipson (1950). However, because this name would, if found to be conspecific with *B. gayana*, threaten that well-established name, it is being proposed for rejection against *B. gayana* in a separate paper.

The name *Verbesina dichotoma* Wall., invalid because of lack of a description, was not one of those validated later by G.Don (see Sprague [1925] for discussion). It is in any case an illegitimate later homonym of *V. dichotoma* Murray.

Notes**:** This species has been confused with *Blainvillea cunninghamii*, but differs in its stiffer, coarser hairs (with distinctly swollen bases), usually more numerous florets per capitulum, larger achenes of which at least the ray achenes are weakly rugose (smooth in *B. cunninghamii*) and the apex of the achenes is truncate or slightly sunken, with the angles continued upwards into short peaks. In Queensland, where both species occur, *B. cunninghamii* is usually found inland in damp forested situations at altitudes to 350–550 m, while *B. acmella* is mostly a strand plant of the Torres Strait islands and coastal Cape York Peninsula.

The embryology of this taxon was described in detail (under the name *B. rhomboidea* Cass.) by Sundara Rajan (1972).

Species excludendae et incertae sedis

Blainvillea brasiliensis (Nees & Mart.) S.F.Blake, *Proc. Biol. Soc. Washington* 38: 85 (1925); *Galophthalmum brasiliense* Nees & Mart., *Nov. Act. Acad. Leopold.-Carol. Nat. Cur.* 12: 8, pl. 2 (1824); *Calyptocarpus brasiliensis* (Nees & Mart.) B.Turner, *Phytologia* 64: 214 (1988). **Type citation:** [Brazil]. “Ad viam Felisbertiam.” [Maximilian].

Now generally treated as *Calyptocarpus brasiliensis*.

Blainvillea biaristata DC., *Prodr.* 5: 492 (1836); *Calyptocarpus biaristatus* (DC.) H.Rob., *Phytologia* 41: 34 (1978). **Type citation:** “In Brasiliae prov. Rio-Grande (v.s. in h. Mus. reg. Par. a Mus. imp. Bras. sub n. 873 miss.).” **Type:** Brésil, Province de Rio Grande, 1833, *C.Gaudichaud 086c*, Herbier Impérial du Brésil No. 873 (holo: P 710003 photo!).

Robinson (1978) advocated transfer of all of *Blainvillea* subgenus *Oligogyne* from *Blainvillea* to *Calyptocarpus*. In the case of *B. biaristatus*, this has recently been accepted in e.g., Zuloaga *et al.* (2008).

Oligogyne bahiensis DC., *Prodr.* 5: 629 (1836); *Blainvillea bahiensis* (DC.) Baker, *Fl. Bras. (Mart.)* 6: 177 (1884); *Calyptocarpus bahiensis* (DC.) Sch.Bip., *Bot. Zeitung (Berlin)* 24: 165 (1866). **Type citation:** “Circa Bahiam Brasiliae legit cl. Blanchet (pl. exs. n. 1706!)”. **Type:** *n.v.* See above under *B. biaristata*.

Oligogyne megapotamica DC., *Prodr.* 5: 629 (1836); *Calyptocarpus megapotamica* (DC.) Sch.Bip., *Bot. Zeitung (Berlin)* 24: 165 (1866). **Type citation:** “In Brasiliae provinciâ Rio-Grande (h. Mus. imp. Bras. n. 874)”. **Type:** Brésil, Province de Rio Grande, 1833, *C.Gaudichaud s.n.*, Herbier Impérial du Brésil No. 874, (holo: P 710004, photo!).

Oligogyne tampicana DC. *Prodr.* 5: 629 (1836); *Blainvillea tampicana* (DC.) Benth. & Hook.f., *Gen. Pl.* 2: 370 (1873). **Type citation:** “circa Tampico de Tamaulipas Mexicanorum legit cl. Berlanier (pl. exs. n. 61!).” **Type:** Mexico: Tampico de Tamaulipas, [10 February] 1827, *Berlandier 61* (holo: G-DC? *n.v.*; iso: P 709867, 709868 & 709869 photo!).

A synonym of *Calyptocarpus vialis* Less. (McVaugh & Smith 1967).

Oligogyne synedrelloides Hook.f. & Arn., *J. Bot. (Hooker)* 3: 316 (1841) [Note that IPNI also lists the name “*Blainvillea synedrelloides* Benth. & Hook.f., *Gen. Pl.* 2: 370 (1873)”, but this combination was only implied, not made, in that publication]. **Type citation:** “Rio Grande, Tweedie.”

A synonym of *Calyptocarpus biaristatus* (DC.) H.Rob. (Robinson 1978; Zuloaga *et al.* 2008).

Blainvillea polycephala Gardner, *London J. Bot.* 7: 89 (1848). **Type citation:** [Brazil] “In dry bushy places near the city of Maranham, May 1841 [G.Gardner].”

Blainvillea racemosa Gardner, *London J. Bot.* 7: 89 (1848); *Blainvillea rhomboidea* var. *racemosa* (Gardner) Baker, *Fl. Bras. (Martius)* 6: 176 (1884). **Type citation:** “In dry, sandy, shady places near Villa de Icó, Province of Ceará, Aug. 1838”, [*G.Gardner*]. **Type:** Brasilia tropica, Prov. Ceara, 1839 [sic], *G.Gardner 1740* (holo: K 54385, photo!).

“*Blainvillea amazonica* Benth. & Hook.f., *Gen. Pl.* 2: 370 (1873)”. This combination is listed in IPNI, but was only implied, not validly made, in the place cited. Bentham & Hooker actually used the name *Lipochaeta amazonica* Poepp. & Endl. (*Nov. Gen. Sp. Pl.* 3: 49, t. 256 [1843]). **Type citation:** “Crescit in insulis arenosis fluminis Amazonum inter Ega et Rio negra”.

From the description and plate, it appears that this is probably a *Wedelia* species.

“*Blainvillea tenuicaulis* Benth. & Hook.f. *Gen. Pl.* 2: 370 (1873)”. This combination is listed in IPNI, but was only implied, not validly made, in the place cited. Bentham & Hooker actually used the name *Wedelia tenuicaulis* Hook.f., which is of doubtful application, (see Global Compositae Checklist: http://compositae.landcareresearch.co.nz/Default.aspx). – *Wedelia tenuicaulis* Hook.f., *Trans. Linn. Soc. London* 20: 213 (1847). **Type citation:** [Galapagos]. “Albemarle Island, Mr

Macrae." **Type:** Galapagos, Albemarle Island, *s.dat.,* McRae s.n. (holo: K 487623 photo!; iso: Galapagos, *s.dat., Macrae s.n.* (US 385744 photo!).

Hooker, in describing *Wedelia tenuicaulis*, considered that it was close to *W. discoidea*, and described it as having discoid capitula with all florets tubular and hermaphrodite. The type in K has attached to it a series of drawings and notes by Hooker. These show a palea which is of the *Blainvillea* type (broad, truncate and laciniate apically), and an achene which is fusiform with 2 erect awns. Although the leaves are rather narrow for this species, it seems likely that this is a rather depauperate specimen of *Blainvillea acmella* (*cf.* notes under *B. acmella* regarding *B. dichotoma*), and that the ray florets were either missing or overlooked by Hooker. It is not *Trigonopterum* (*Macraea*) *laricifolia* (Hook.f.) W.L.Wagner & H.Rob.

Blainvillea lanceolata J.G.Baker, *Fl. Bras. (Mart.)* 6: 176 (1884). **Type citation:** "Habitat in prov. Alto Amazonas in silvis Japurensibus: Martius."

Blainvillea dallo-vedovae Terrac., *Annuar. Reale Ist. Bot. Roma* 5: 107 (1894). **Type citation:** [Somalia]. Reference not traced.

Probably *B. gayana.*

Blainvillea dichotoma Luetzelb., *Estud. Bot. Nordeste i. (Publ. Insp. Fed. Obras Contr. Secc., Rio de Janeiro,* No. 57, Ser. I.A.) 41 (1922–3).

Listed in *Index Kewensis* as a *nom. nud.,* i.e. *nom. inval.* Not to be confused with the (also invalid) *Verbesina dichotoma* Wall. [= *B. acmella*] or *Verbesina dichotoma* Murray (≡ *Blainvillea dichotoma* (Murray) Hemsl.).

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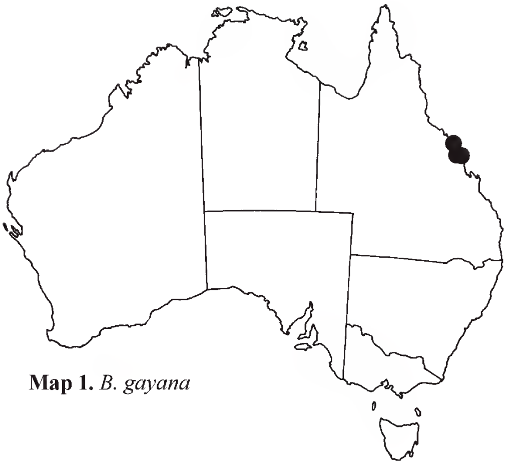
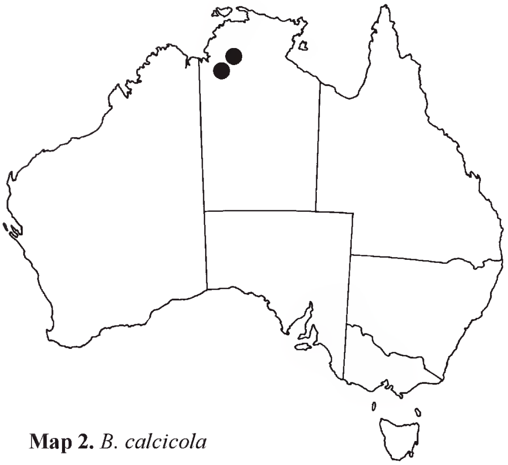
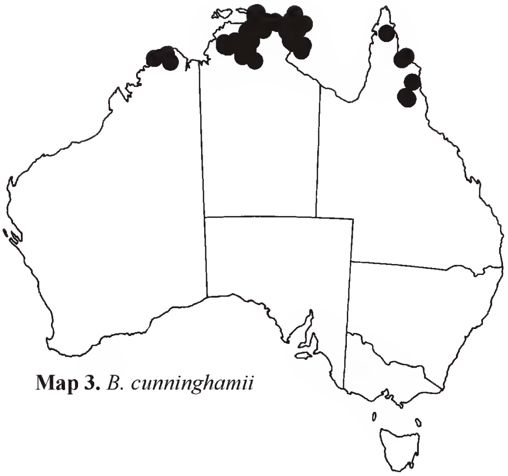
Maps 1-4. Distribution of Australian species of *Blainvillea*. Note that *B. gayana* and *B. acmella* also have extensive extra-Australian distributions (see text for details).



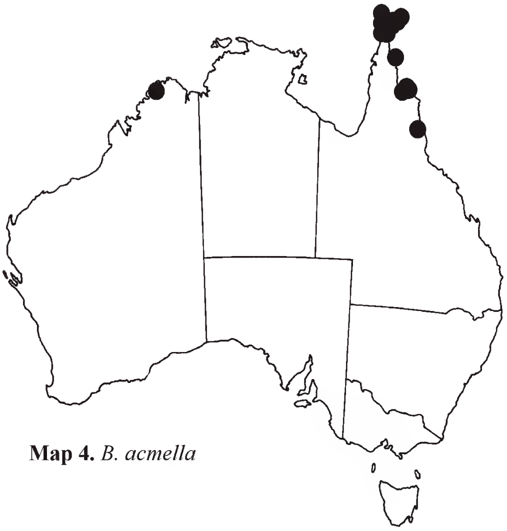
Map 1. *B. gayana*



Map 2. *B. calcicola*



Map 3. *B. cunninghamii*



Map 4. *B. acmella*

A taxonomic revision of *Hollandaea* F.Muell. (Proteaceae)

A.J. Ford[1] & Peter H. Weston[2]

Summary

Ford, A.J. & Weston, P.H. (2012). A taxonomic revision of *Hollandaea* F.Muell. (Proteaceae). ***Austrobaileya* 8(4)**: **670–687**. The genus *Hollandaea* (Proteaceae) is revised, redescribed and distinguished from its closest relative, the genus *Helicia*. *Hollandaea porphyrocarpa* A.J.Ford & P.H.Weston and *H. diabolica* A.J.Ford & P.H.Weston are newly described, illustrated and diagnosed from related species. Notes on habitat, distribution, and conservation status for all four species of *Hollandaea* are provided. A key to the species of *Hollandaea* is presented.

Key Words: Proteaceae, *Hollandaea, Hollandaea diabolica, Hollandaea porphyrocarpa, Hollandaea riparia, Hollandaea sayeriana*, Australia flora, Queensland flora, taxonomy, identification key, new species

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Introduction

Hollandaea F.Muell. is a genus of four species that is endemic to Australia (Cooper & Cooper 2004) with all species being confined to the Wet Tropics area of north eastern Queensland. The name *Hollandaea* first appeared in the literature in April 1887 (Anon. 1887) prior to its formal publication in June 1887 (Mueller 1887), being noted in a report of a meeting at which Mueller exhibited specimens and indicated his intention to publish.

Hollandaea sayeriana (F.Muell.) L.S.Sm. was originally described as *Helicia sayeriana* F.Muell. by Mueller (1886). The following year, as outlined above, Mueller erected *Hollandaea* and transferred *Helicia sayeriana* to it, as *H. sayeri* F.Muell. (Mueller 1887). Unfortunately, this species name was illegitimate because the specific epithet was nomenclaturally superfluous when published. Bailey (1899) described *Hollandaea lamingtoniana* F.M.Bailey which appeared as such in *The Queensland Flora* (Bailey 1901), but was rightly transferred to *Helicia* Lour. by Smith (1952), who attributed the new combination to C.T.White. Engler (1888) overlooked or was unaware of these taxa in his treatment of the Proteaceae and Smith (1956) made the legitimate combination *H. sayeriana*. *Hollandaea* became accepted as a distinct monotypic genus (see e.g. Johnson & Briggs 1963; Venkata Rao 1971; Johnson & Briggs 1975), differing from all other genera of Proteaceae in producing a follicular fruit containing numerous wingless seeds.

Johnson & Briggs (1963: 42) placed Hollandaea in the subfamily *Grevilleoideae* Engl. as a genus incertae sedis on the grounds that it "... shows little advancement from the primitive Grevilleoid condition, except perhaps in its undivided leaves, thick wingless seeds with obliquely arranged cotyledons, fully adnate filaments, and bright pink flowers (crimson in bud), which do not, however, show any particular structural adaptation to ornithophily". By "primitive Grevilleoid condition" they meant a hypothetical ancestral suite of states including follicular fruits containing numerous, winged seeds, the production of pseudoracemose inflorescences bearing lateral pairs of actinomorphic flowers and a haploid chromosome number of $n = 14$. Venkata Rao (1971) agreed with Johnson & Briggs in placing *Hollandaea* in subfamily *Grevilleoideae* and placed it in his tribe *Telopeeae* Venk.Rao on the basis of its multiple

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ovules and follicular fruit. Moreover, he placed *Hollandaea*, together with *Knightia* R.Br. and *Darlingia* F.Muell., in the (nomenclaturally invalid) new subtribe *Hollandinae* Venk.Rao. Venkata Rao's *Telopeeae* was considered by Johnson & Briggs (1975) to be polyphyletic, as it included parts of their tribes *Embothrieae* L.A.S.Johnson & B.G.Briggs, *Knightieae* L.A.S.Johnson & B.G.Briggs and *Helicieae* L.A.S.Johnson & B.G.Briggs. They argued (Johnson & Briggs 1975: 108) that *Hollandaea* had been shown by their studies to be "more probably a member of the Helicean branch of the subfamily" and that it shared "only primitive characters with Knightieae or Embothrieae". Johnson & Briggs' tribe *Helicieae* included *Hollandaea* in its own subtribe, *Hollandaeinae* L.A.S.Johnson & B.G.Briggs, as well as *Triunia* L.A.S.Johnson & B.G.Briggs in the monotypic subtribe *Triuniinae* L.A.S.Johnson & B.G.Briggs and two other genera, *Xylomelum* Sm. and *Helicia*, in the subtribe *Heliciinae* L.A.S.Johnson & B.G.Briggs. These four genera were grouped together on the basis of the putatively synapomorphic loss of divided pre-adult leaves, a character state that is found in numerous other genera of *Grevilleoideae*. These other genera were placed by Johnson & Briggs in other tribes on the basis of other putative synapomorphies.

Hollandaea remained a monotypic genus until Hyland (1995) added a second species, describing the highly restricted *Hollandaea riparia* B.Hyland from the Roaring Meg Creek area, south of Cooktown. This species was sampled, along with species of 45 other genera, in the first published molecular phylogenetic analysis of the Proteaceae (Hoot & Douglas 1998). Hoot and Douglas' analysis included genera that had been proposed by Venkata Rao (1971 – *Knightia*) and Johnson & Briggs (1975 - *Helicia, Xylomelum, Triunia*) to be closely related to *Hollandaea* and showed very strongly (100% bootstrap support) that the sister group of *Hollandaea* is *Helicia*, contrary to all previous classifications. The relationships of this clade were unresolved, forming part of a polytomy of 11 lineages that together constituted the *Grevilleoideae* in their best estimate of relationships (Hoot & Douglas 1998: 309: figure 2). The grouping of *Hollandaea* and *Helicia* as sister taxa was also found by Weston & Barker (2006) in their supertree analysis of the results of published and unpublished molecular phylogenies of the Proteaceae. They recognised this clade as the subtribe *Heliciinae*, one of four subtribes plus four ungrouped genera in the tribe *Roupaleae* Meisn. in their new classification of the Proteaceae. Monophyly of the *Roupaleae* is poorly supported as is resolution of its internal relationships. Conflicting evidence from different molecular data sets has prevented identification of the sister group of the *Heliciinae* with confidence: *rbcL* cpDNA sequences strongly group *Helicia* and *Hollandaea* with *Knightia* (Barker et al. 2007) but this putative relationship is not corroborated by analyses of other chloroplast loci (Hoot & Douglas 1998) nor by analysis of ITS nuclear ribosomal DNA sequences (Weston & Barker 2006). A supermatrix analysis of the Proteaceae conducted by Sauquet *et al.* (2009), using all available DNA sequences (1 nuclear and 7 chloroplast regions) and phylogenetic analyses using both Bayesian probability and maximum parsimony criteria, again grouped *Helicia* with *Hollandaea* as a clade, with a posterior probability of 1.0 and 100% parsimony bootstrap support. In this analysis, the sister group of the *Heliciinae* was resolved as the monotypic genus *Megahertzia* A.S.George & B.Hyland, with a posterior probability of 0.99 but parsimony bootstrap support of only 59%.

Weston & Barker's (2006) subtribe *Heliciinae* is characterised morphologically by the possession of anatropous ovules that develop, on fertilization, into thick, unwinged seeds. These states are found elsewhere in the tribe *Roupaleae*. *Xylomelum* has anatropous ovules and *Triunia* has fleshy and unwinged seeds (Weston 2006). Detailed analysis of the distribution of these character states in the Proteaceae is needed to determine which, if either, of them is synapomorphic for the *Heliciinae*.

Hollandaea and *Helicia* are distinguished morphologically from one another by their ovary, fruit and seed morphology (Foreman

1995; Hyland 1995). The ovary of *Hollandaea* contains ovules borne in an oblique orientation from lateral placentae. Until now, *Hollandaea* has been characterised as consistently having four or more ovules per ovary but this now needs to be amended, as the here-described *Hollandaea diabolica* has 2–4 ovules. On fertilization, these develop into angular seeds that are released at maturity from a follicular fruit. The ovary of *Helicia* contains two erect ovules borne from basal placentae. On fertilization, one (or rarely both) of these develops into a globose to ovoid or ellipsoid seed (hemispherical to hemielliptical if both ovules develop), enclosed within an indehiscent (drupaceous or dry) fruit. Outgroup comparisons with other members of the tribe *Roupaleae* and with its sister group (tribe *Banksieae* Dumort. plus *Sphalmium* B.G.Briggs, B.Hyland & L.A.S.Johnson according to Weston & Barker [2006]) suggest that indehiscent fruit may be a synapomorphy for *Helicia*. Johnson & Briggs (1975) assumed that numerous ovules per carpel is plesiomorphous for the Proteaceae as a whole and for all subgroups that include multiovulate taxa. According to this interpretation, reduction to two ovules would also be a synapomorphy for *Helicia*. However, outgroup comparison suggests the possibility that multiple ovules might be more parsimoniously interpreted as a synapomorphy for *Hollandaea*.

In the early 1990s two new proteaceous taxa were observed and collected from the vicinity of a walking track on the Main Coast Range near Mossman, north-east Queensland. Significantly, one of these taxa (described below as *Hollandaea diabolica* A.J.Ford & P.H.Weston) was investigated by Carpenter (1994) for leaf cuticle morphology. In his opinion, “cuticular morphology…. indicates that this taxon cannot be aligned with any described genus, although it is most likely to be allied to Helicieae”. Since that time, additional specimens have been collected and new locations of each species have been documented. The currently accepted morphological circumscription of *Hollandaea* includes one of these taxa and needs to be modified only minimally, by expanding the range of ovule numbers to 2–20, to encompass the other. Both taxa are described below as new species of *Hollandaea*.

Materials and methods

The study is based upon examination of herbarium material from BRI, CNS and NSW with field observations by the first author. All specimens cited have been seen by one or both authors.

Measurements of the floral parts and fruits of *Hollandaea* are based on material preserved in 70% ethanol. Common abbreviations in the specimen citations are: dbh (diameter at breast height), E.P. (Experimental Plot), L.A. (Logging Area), N.P.R. (National Park Reserve), S.F.R. (State Forest Reserve) and T.R. (Timber Reserve).

Estimates of extent of occurrence *sensu* IUCN (2001) were derived from validation of original collection localities. These data points were loaded into ESRI ArcView 3.2 and the draw polygon feature used to calculate the area between the points. Area of occupancy estimates were derived from a digital Regional Ecosystem map together with the first author’s knowledge of vegetation types and habitats within the Wet Tropics bioregion (hereafter referred to as the Wet Tropics) (Environment Australia 2005). These estimates are not strictly RE driven, therefore they possibly represent a relatively more accurate picture of occurrence and occupancy.

Species names in the distribution and habitat notes are those that are currently accepted by the Queensland Herbarium (BRI).

The abbreviation RE in the distribution and habitat notes refers to Regional Ecosystem, descriptions of which can be viewed at: www.derm.qld.gov.au/wildlife-ecosystem/biodiversity/regional_ecosystems/index.php

NCA is an abbreviation for the Queensland Nature Conservation Act (1992) and its associated schedules. Discussions of conservation status are made in reference to the criteria of the IUCN (2001).

Species are arranged alphabetically. Suggested affinities between species are indicated in the *Affinities* section for each taxon.

Character phylogenies of qualitative morphological characters were reconstructed by mapping them onto a phylogenetic tree of proteaceous genera (Sauquet *et al.* 2009) using the parsimony option in Mesquite version 2.75. The following characters (and their states) were analysed in this way: trichome morphology (basifixed or medifixed), ovule form (anatropous, hemitropous or orthotropous); ovule number (two, more than two), ovule placentation (basal, lateral, apical), micropyle orientation (micropyle pointing towards base of locule or pointing obliquely across locule), cotyledon thickness (laminar or fleshy), seed wing (absent or present).

Character phylogenies

The four character states that diagnose the subtribe *Heliciinae* from other members of the tribe *Roupaleae* – possession of medifixed trichomes, anatropous ovules, fleshy cotyledons, and unwinged seeds were all resolved unequivocally as synapomorphies for the *Heliciinae* on the tree of Sauquet *et al.* (2009). Of the character states distinguishing *Hollandaea* from *Helicia*, multiple ovules was resolved as synapomorphic for *Hollandaea* and indehiscent fruit as synapomorphic for *Helicia*.

Taxonomy

Hollandaea F.Muell., *Australas. Chem. Druggist* 2(6): 173 (June 1887). **Type:** *H. sayeriana* (F.Muell.) L.S.Sm.

***Derivation of name*:** Named after Sir Henry Thurston Holland, first Viscount Knutsford (1825–1914), Secretary of State for the Colonies between 1887 and 1892.

Single or multistemmed trees or large shrubs. Trichomes medifixed. Bark compact and close, usually inconspicuously lenticellate, lacking any significant features. Leaves alternate, spirally inserted, simple; seedlings lacking cataphylls; juvenile leaves unlobed, prominently toothed or rarely entire; adult leaves entire or inconspicuously toothed, venation brochidodromous, primary venation conspicuous on both surfaces, secondary venation discernible, tertiary venation discernible. Petioles swollen, pulvinate. Conflorescence an elongated unbranched raceme of flower pairs, lateral, cauliflorous, ramiflorous or borne just proximal to the lowest/oldest leaves, usually pendulous, composed of 54–224 flowers; each flower pair subtended by a scale-like bract (common bract); common peduncle present. Flowers bisexual, pedicellate on common peduncle, hypogynous. Floral bract conspicuous, inserted variously along pedicel. Perianth actinomorphic, differentiated into a narrow basal claw and clavate apical limb in mature bud; tepals 4, not connate, glabrous adaxially, glabrous or hairy abaxially, splitting with individual tepals coiling and reflexed at anthesis, caducous following anthesis. Stamens 4, equal; filaments adnate to tepals; anthers 2-locular, with a distinct mucro, dehiscing introrsely through longitudinal slits. Hypogynous glands 4, free or connate, fleshy. Gynoecium glabrous; ovary sessile, ovules anatropous, obliquely oriented, 2–20; placentae lateral; style straight; tip clavate, functioning as a pollen presenter; stigma terminal. Fruit dehiscent, follicular, usually asymmetrical; style persistent. Seeds fleshy, unwinged, usually angular, 1–20 per fruit, testa thin. Germination usually hypogeal. Cotyledons fleshy. $2n = 28$

***Distribution*:** Endemic to the Wet Tropics, Queensland, Australia; four species.

Key to the species of *Hollandaea*

The following key allows for both flowering and fruiting specimens. (See Cooper & Cooper 2004: 414, 415 for exquisite fruit illustrations).

1 Flowers present **2**
1. Fruit present **5**

2 Tepal abaxial surface clothed in medifixed hairs **3**
2. Tepal abaxial surface glabrous **4**

3 Leaf base cuneate, conflorescence axis > 150 mm long . . . . **4. H. sayeriana**
3. Leaf base attenuate, conflorescence axis < 110 mm long. . . . . **2. H. porphyrocarpa**

4 Leaf margin recurved, leaf apex obtuse to retuse, conflorescence axis hairy, tepals creamish, yellowish or with green hue . . . . **1. H. diabolica**
4. Leaf margin flat, leaf apex obtuse to acute, conflorescence axis glabrous, tepals purplish or purple with blue-green hue . . . . **3. H. riparia**

5 Fruit surface sculptured **6**
5. Fruit surface smooth **7**

6 Fruit smoothly (and shallowly) wrinkled to the touch, seeds 14–20 mm long, leaf apex acute-obtuse . . . . **3. H. riparia**
6. Fruit roughly (and deeply) wrinkled to the touch, seeds 22–25 mm long, leaf apex retuse-obtuse . . . . **1. H. diabolica**
7 Fruit green when ripe, > 60 mm long . . . . **4. H. sayeriana**
7. Fruit purple when ripe, < 50 mm long . . . . **2. H. porphyrocarpa**

1. **Hollandaea diabolica** A.J.Ford & P.H.Weston, **species nova**. Distinguished from *H. riparia* by fruit shape (± equidimensional versus longer than wide), seed size (22–25 mm versus 14–20 mm), leaf apex (obtuse-retuse versus obtuse-acute), leaf length:width ratio (<3.6:1 versus >4:1), tepal colour (creamish or yellowish versus purplish) and ovule number (2–4 versus 6–8). **Typus:** Queensland. Cook District: Pinnacle Rock Track [Daintree National Park, NW of Mossman], 1 February 1996, *B. Hyland 25914RFK* (holo: BRI; iso: CNS, NSW).

Proteaceae sp. ‘Devils Thumb’; Carpenter (1994: 291, 292).

Orites sp. (Pinnacle Rock Track WWC *867*); Hyland et al. (2003).

Hollandaea sp. (Devils Thumb); Cooper & Cooper (2004: 414).

Hollandaea sp. (Devils Thumb P.I.Forster+ PIF10720); Forster & Edginton (2007: 171; 2010: 165).

***Illustrations*:** Cooper & Cooper (2004: 414) as *Hollandaea* sp. (Devils Thumb); Hyland *et al.* (2003) as *Orites* sp. (Pinnacle Rock Track WWC *867*).

Single stemmed canopy or subcanopy trees to 25 m high, with trunk diameters to 50 cm dbh recorded; buttresses absent. Bark nondescript. Terminal and axillary buds clothed in dark brown, minute, medifixed hairs. Branchlets initially somewhat angled and sparsely clothed in mostly pale-coloured minute medifixed hairs, becoming terete and glabrous. Seedlings: first leaves sub-opposite, toothed, stem hairy. Juvenile leaves simple, unlobed, prominently toothed. Leaves alternate, petiolate, discolorous, dull or slightly shiny on adaxial surface and very pale (± pruinose) on abaxial surface; lamina elliptic to elliptic-obovate, 69–155 × 20–55 mm, base attenuate, apex retuse to obtuse with acumen absent; margin usually recurved; both surfaces glabrous although rare pale-coloured minute medifixed hairs may be present on midvein on adaxial surface; midvein raised on each surface, more prominent on abaxial surface; venation slightly bullate on adaxial surface, equally conspicuous on both surfaces, primary venation conspicuous on both surfaces with 5–8 primary lateral veins on each side of midvein. Petioles slightly swollen, 3–4 mm long, slightly convex on adaxial surface; glabrous or with rare, minute, dark-coloured medifixed hairs, appearing to be winged and much longer due to the attenuate nature of the leaf base. Conflorescences ramiflorous or just below the lowest/oldest leaves, composed of 54–140 flowers; conflorescence axis 48–120 mm long, weakly angled (not terete), longitudinally striated (when dry), moderately clothed in brown medifixed hairs. Common bracts c. 0.7 mm long, ovate, with mostly marginal hairs. Floral bracts c. 0.5 mm long, ovate, glabrous except for minute pale brown marginal hairs, inserted usually about halfway along pedicel. Pedicels terete, 2.1–3 mm long, sparsely clothed in brown medifixed hairs, paired on a peduncle *c.* 1 mm long. Tepals 27–33 mm long and clavate at apex in mature bud, splitting distally at first with individual tepals coiling and reflexed at anthesis, apex acute, cream, yellow or greenish, glabrous on abaxial and adaxial surface, Stamens with free filament tips 0.4–0.8 mm long, inserted *c.* 5 mm from tepal apex; anthers 4–5 mm long (including a blunt appendage/mucro of *c.* 0.3 mm long). Hypogynous glands free, fleshy. Style 20–24 mm long; pollen presenter 3–4 mm long; ovary 1.9–2.6 mm long, ovules 2–4, placenta marginal. Fruit 40–50 mm diameter, asymmetrical but appearing globose to spherical, deeply wrinkled (with a honeycomb texture), orange-green, leathery on outer surface, woody on inner surface, style persistent. Seeds 1–4 per fruit, 22–25 mm long on the longest axis, usually smooth, testa thin, radicle *c.* 2mm long. Germination hypogeal. **Fig. 1**.

***Additional specimens examined*: Queensland.** COOK DISTRICT: Pinnacle Rock Track, 4 km W of Karnak, Jun 1992, *Forster PIF10720 et al.* (BRI, CNS); Pinnacle Rock Track, Feb 1996, *Hyland 25913RFK* (CNS); *loc. cit*., Feb 1996, *Hyland 25909RFK* (CNS); West of Karnak, via Mossman, Jan 1995, *Cooper 867 & Cooper* (BRI, CNS); *loc. cit*., Jan 1995, *Cooper 868 & Cooper* (BRI, CNS); Daintree N.P., Pinnacle Rock Track, NW of Mossman, just before the Gleichenia area, Oct 2005, *Ford 4747 et al.* (BRI, NSW, CNS); *loc. cit*., Oct 2005, *Ford 4750 et al.* (BRI, NSW, CNS); Pinnacle Rock, Whyanbeel, Sep 1991, *Sankowsky 1205* (CNS); East Mulgrave River, Bellenden Ker, Nov 1995, *Jensen 525* (CNS).

***Distribution and habitat*:** *Hollandaea diabolica* is endemic to the Wet Tropics bioregion in north-eastern Queensland, where it is currently known to occur on the eastern fall of the Main Coast Range west of Mossman (see above) and an area on the East Mulgrave River to the south of Mt Bellenden Ker (**Map 1**). On the Main Coast Range it inhabits very wet mountainous notophyll vine-forests/rainforests on soils derived from granite. Here the common canopy species include: *Acmena hemilampra* subsp. *orophila* B.Hyland, *Balanops australiana* F.Muell., *Elaeocarpus* sp. (Mossman Bluff D.G.Fell 1666), *Halfordia kendack* (Montrouz.) Guillaumin, *Planchonella euphlebia* (F.Muell.) W.D.Francis, *Syzygium* spp. and *Sphalmium racemosum* (C.T.White) B.G.Briggs, B.Hyland & L.A.S.Johnson. Common small trees and shrubs include: *Chionanthus axillaris* R.Br., *Haplostichanthus submontanus* Jessup subsp. *submontanus*, *Linospadix minor* (W.Hill) F.Muell., *Oraniopsis appendiculata* (F.M.Bailey) J.Dransf., A.K.Irvine & N.W.Uhl, *Pittosporum rubiginosum* A.Cunn., *Schistocarpaea johnsonii* F.Muell., *Steganthera cooperorum* Whiffin, *S. macooraia* (F.M.Bailey) P.K.Endress and *Symplocos graniticola* Jessup. No floristic assemblage information is available for the East Mulgrave River population. Altitudinal range, from existing specimens, is 450–1000 m.

Hollandaea diabolica has been collected in RE7.12.16a (East Mulgrave and Main Coast Range populations) and 7.12.20 (Main Coast Range population), the former regarded as a very common and widespread community within the Wet Tropics. However, it is very likely that the two populations have different floristic associations as they are on either side of the Black Mountain Corridor (BMC) and several of the species listed above do not occur south of the BMC. Although both *H. diabolica* and *H. porphyrocarpa* occur in RE 7.12.20 they have not yet been recorded as co-occurring.

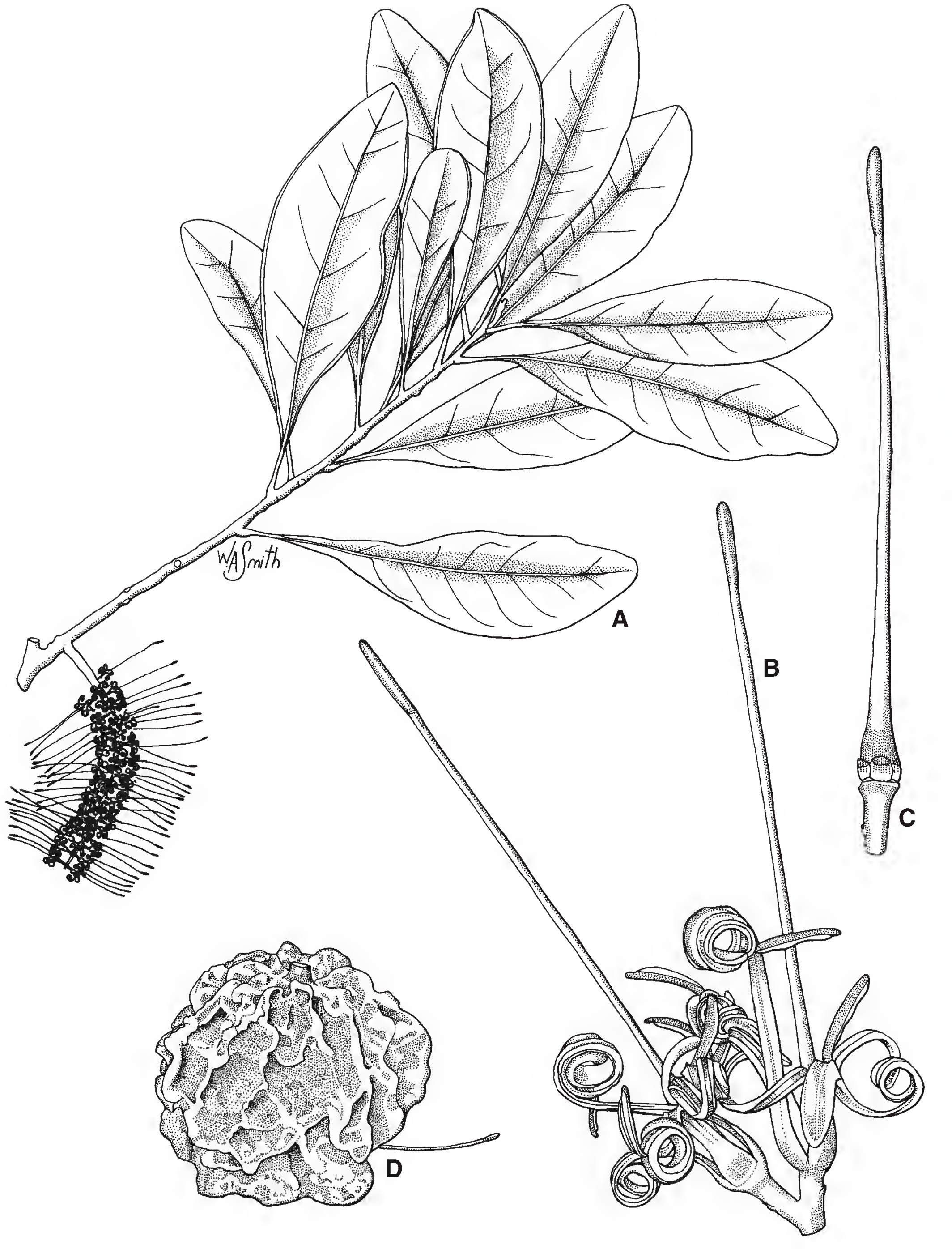


Fig. 1. *Hollandaea diabolica*. A. branchlet with inflorescences ×0.4. B. paired flowers at anthesis showing floral bracts ×3. C. close up of ovary showing hypogynous glands and floral bract ×3. D. lateral view of fruit with persistent style ×1. A–C from *Hyland 25914RFK* (CNS); D from *Cooper 868 & Cooper* (CNS). Del. W.Smith

Phenology: Flowers have been recorded in January and February; fruits have been recorded in January.

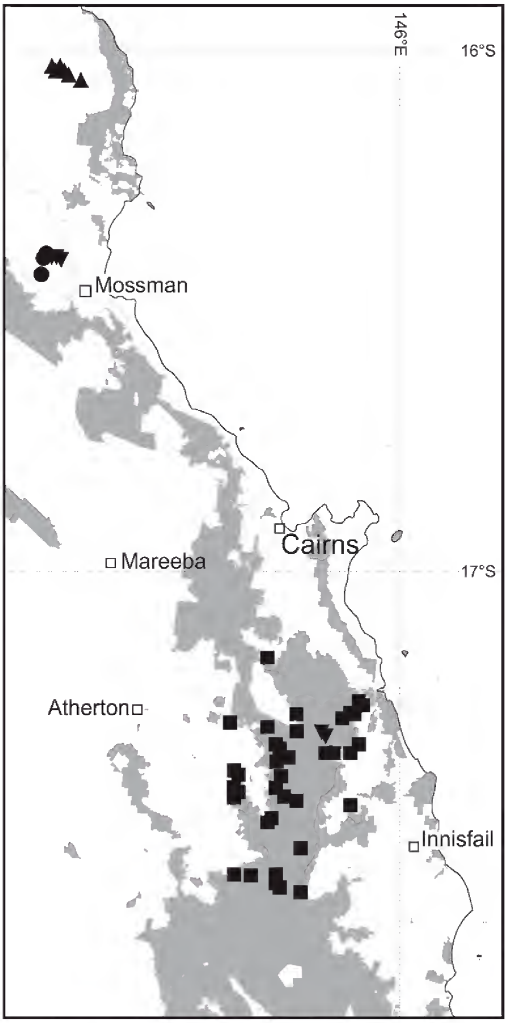
Notes: The woody remains of the fruit are usually conspicuous under mature trees. These remains, and fallen yellowish leaves, are often the only clues that this species is in the area. The perianth is recorded as being creamish to yellow or greenish; the style is pink to mauve and cream at the apex; the ovary is pink and hypogynous glands are yellowish.

Juvenile leaves have an acute-acuminate apex and lack the conspicuous retuse-obtuse apex of adult leaves. With such an apex, seedlings (and saplings) could easily be confused with local glabrous species of *Helicia*.

The East Mulgrave River collections are sterile and no fruit remnants were recorded. Until fertile collections of this population are made to suggest otherwise we have incorporated that population's data into the above descriptions and the following assessment.

Affinities: *Hollandaea diabolica* appears to be most closely related to *H. riparia*, in that they share the features of ± pruinose abaxial leaf surface, wrinkled/verrucose fruit surface, glabrous abaxial tepal surface and a relatively low ovule number. *H. diabolica* can be distinguished from *H. riparia* on the following features: fruit shape (± equidimensional versus longer than wide, respectively), larger seeds (22–25 mm versus 14–20 mm), leaf apex (obtuse-retuse versus obtuse-acute), leaf length:width ratio (<3.6:1 versus >4:1), usually shorter conflorescence axis (48–120 mm versus 110–155 mm) and fewer ovules (2–4 versus 6–8). Comparisons between all species of *Hollandaea* are provided in **Table 1**.

Conservation Status: All existing collections have been made within the World Heritage Area of the Wet Tropics bioregion. *Hollandaea diabolica* only occurs in the Daintree and Wooroonooran National Parks. As it has a very disjunct and narrow geographical range, with an extent of occurrence estimated to be less than 50 km^2 and an area of occupancy estimated to be less than 5 km^2, it is considered at risk at this time. An approximate estimate of the population sizes is not known, but an optimistic guess of less than 100 mature individuals on the Main Coast Range, and perhaps a similar number at the East Mulgrave River is neither conservative nor extravagant. A thorough search of nearby areas is required to determine the population size and structure. Nonetheless, due to the extremely disjunct nature, limited distribution and estimated population sizes we recommend *H. diabolica*



Map 1. Distribution of *Hollandaea* species in north-east Queensland (*H. diabolica* ▼, *H. porphyrocarpa* ●, *H. riparia* ▲, *H. sayeriana* ■)

being listed as “Vulnerable” under the IUCN (2001) criteria as it fulfills the criteria under categories VU, D1 and D2.

***Etymology*:** The specific epithet has been formed arbitrarily and comes from the Latin *diabolus*, (devil) in reference to the locality, Devils Thumb.

2. Hollandaea porphyrocarpa A.J.Ford & P.H.Weston, **species nova**. Distinguished from H. sayeriana by the leaf base (attenuate versus cuneate), fruit size (35–45 mm versus 60–150 mm), conflorescence axis length (52–103 mm versus 150–380 mm) and anther length (4.5–6 mm versus 2–3.1 mm). **Typus:** Queensland. Cook District: Daintree National Park, Pinnacle Rock Track, NW of Mossman, beyond the Gleichenia area, 13 October 2005, *A.Ford 4742, W.Cooper & R.Russell* (holo: BRI [2 sheets + spirit]; iso: CNS, K, L, MEL, MO, NSW).

Hollandaea sp. (Pinnacle Rock Track P.I.Forster+ PIF10714); Forster & Edginton (2007: 171; 2010: 165).

Hollandaea sp. (Pinnacle Rock Track PIF10714); Hyland *et al.* (2003).

Hollandaea sp. (Pinnacle Rock Track); Cooper & Cooper (2004: 415).

***Illustrations*:** Cooper & Cooper (2004: 415) as *Hollandaea* sp. (Pinnacle Rock Track); Hyland *et al.* (2003) as *Hollandaea* sp. (Pinnacle Rock Track PIF10714).

Single stemmed canopy or subcanopy trees to 15 m high, with trunk diameters to 20 cm dbh recorded; buttresses absent. Terminal and axillary buds clothed in minute, dark brown hairs. Branchlets terete, glabrous to glabrescent, smooth. Seedlings: cotyledons obovate, 15–17 × 13–17 mm, base sagittate; hypocotyl glabrous, first leaves sub-opposite, toothed, stem hairy. Juvenile leaves prominently toothed with 4–8 teeth on each side. Adult leaves petiolate, discolorous, dull on adaxial and abaxial surfaces; lamina elliptic to elliptic-obovate, 90–157 × 32–60 mm, base attenuate, apex acuminate to acute-acuminate with acumen 3–12 mm long; margin flat or slightly recurved, entire or sparsely denticulate, both surfaces glabrous; midvein raised on each surface, more prominently so on abaxial surface; faintly 3-veined at base, primary venation conspicuous on both surfaces with 6–10 primary lateral veins on each side of the midvein, equally conspicuous on both surfaces. Petioles swollen, pulvinate, 4–6 mm long, ± terete, glabrous, appearing to be winged and much longer than they are due to the very attenuate shape of the leaf base. Conflorescences cauliflorous, ramiflorous or just below the lowest/oldest leaves, composed of 58–106 flowers; conflorescence axis 52–103 mm long, weakly angled (not terete) when dry, densely clothed in pale to mid-brown hairs. Common bracts *c.* 0.9 mm long, lanceolate, with mostly marginal hairs. Common peduncle of flower pair *c.* 2 mm long. Floral bracts triangular to ovate, *c.* 0.7 mm long, glabrous except for minute, pale brown marginal hairs, inserted usually about halfway along pedicel. Pedicels terete, 3–4.5 mm long, clothed in pale brown hairs. Tepals 26–29 mm long in mature bud, splitting proximally at first with individual tepals coiling and reflexed at anthesis, apex acute, pink, moderately clothed on abaxial surface in pale brown hairs, glabrous adaxially. Stamens with free filament tips *c.* 0.4 mm long, inserted *c.* 7 mm from tepal apex; anthers 4.5–6 mm long (including a mucro of *c.* 0.7 mm long). Hypogynous glands connate, fleshy. Style 16–20 mm long; pollen presenter *c.* 5 mm long; ovary 2.5–3 mm long, ovules 12–16, placenta marginal. Fruit leathery (neither fleshy nor woody), 35–45 mm long, *c.* 30 mm diameter, asymmetrical and somewhat hemispherical in shape with one side nearly flat, smooth, purplish, style persistent. Seeds angular, many-faced with the abaxial face convex, 6–9 per fruit, 13–16 mm long on the longest axis, testa thin, radicle *c.* 3mm long, adaxial surface of cotyledons flat. Germination epigeal to hypogeal (cotyledons usually splitting the testa and forming a distinctive hypocotyl). **Fig. 2**.

***Additional specimens examined*:** **Queensland**. Cook District: Pinnacle Rock Track, 4.5 km W of Karnak, Mossman, Jun 1992, *Forster PIF10714 et al.* (BRI, CNS); Pinnacle Rock Track, Feb 1996, *Hyland 25910RFK* (CNS); Ridges above the Mossman River in the Mossman Gorge, May 1991, *Russell s.n.* (CNS); Pinnacle Rock, Whyanbeel, Sep 1991, *Sankowsky 1206* (CNS); West of

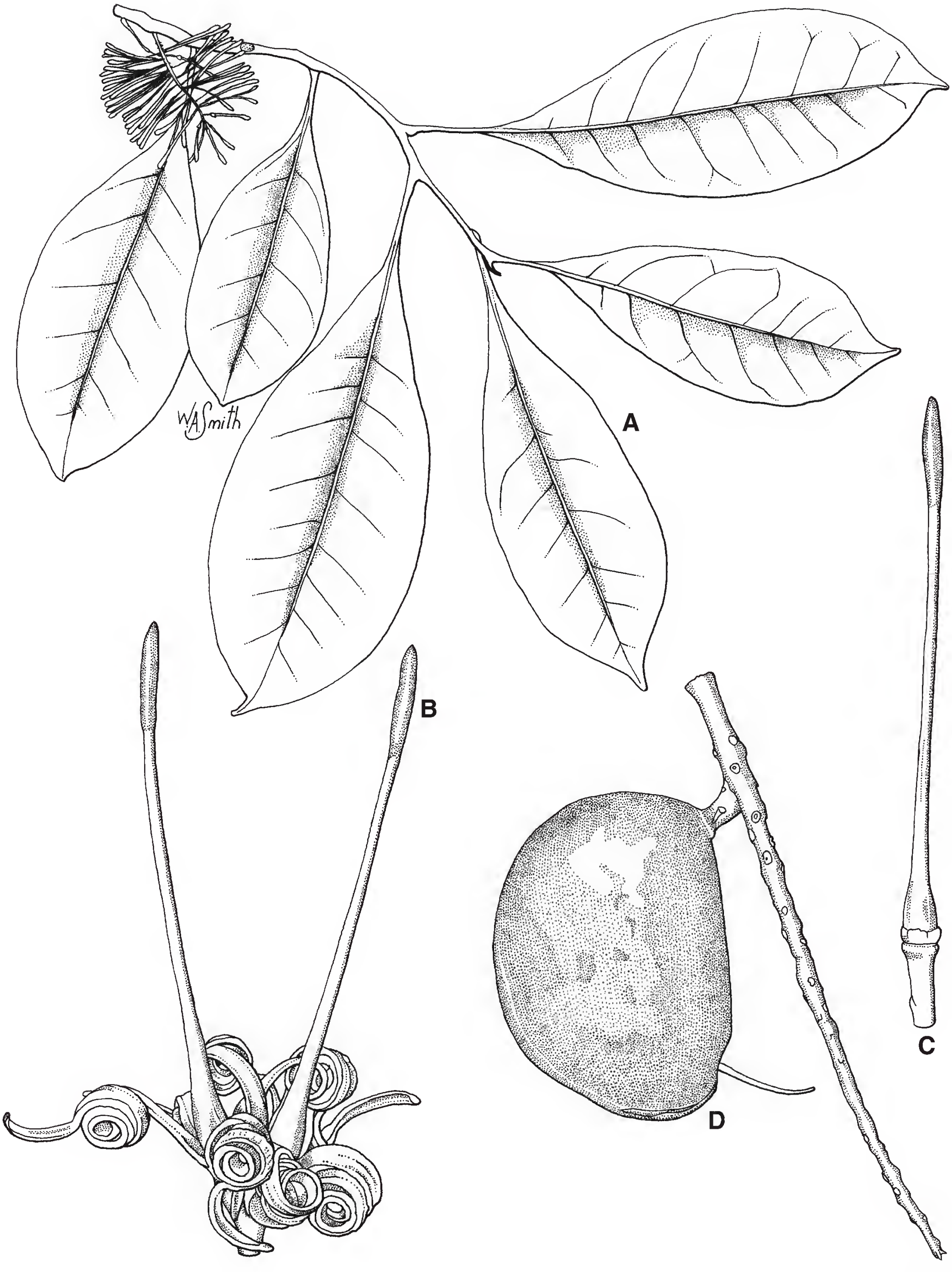


Fig. 2. *Hollandaea porphyrocarpa*. A. branchlet with inflorescences ×0.4. B. paired flowers at anthesis ×3. C. close up of ovary showing hypogynous glands and floral bract ×3. D. lateral view of fruit with persistent style ×1. A–C from *Ford 4742 et al.* (BRI); D from *Cooper 865 & Cooper* (CNS). Del. W.Smith

Karnak, via Mossman, Dec 1994, *Cooper 865 & Cooper* (BRI, CNS); Daintree N.P., Pinnacle Rock Track, NW of Mossman, beyond the Gleichenia area, Oct 2005, *Ford 4745, Cooper & Russell* (BRI, CNS, NSW).

***Distribution and habitat*:** *Hollandaea porphyrocarpa* is endemic to the Wet Tropics bioregion in north-eastern Queensland, where it is currently known to occur on the eastern fall of the Main Coast Range west of Mossman (**Map 1**). This area is locally known as either "Devils Thumb" or "Pinnacle Rock". It inhabits very wet mountainous notophyll to microphyll vine-forests or vine-fern thickets/rainforests on soils derived from granite. Common canopy species include: *Cryptocarya corrugata* C.T.White & W.D.Francis, *Elaeocarpus elliffii* B.Hyland & Coode, *Halfordia kendack, Myrsine oreophila* Jackes, *Niemeyera* sp. (Mt Lewis A.K.Irvine 1402) and *Sphalmium racemosum*. Common small trees and shrubs include: *Ardisia pachyrrhachis* (F.Muell.) F.M.Bailey, *Austromuellera valida* B.Hyland, *Baloghia parviflora* C.T.White, *Catalepidia heyana* (F.M.Bailey) P.H.Weston, *Chionanthus axillaris, Pittosporum rubiginosum, Psychotria spp., Steganthera cooperorum, Triunia montana* (C.T.White) Foreman and *Wendlandia connata* C.T.White. Conspicuous understory species include: *Cyathea rebeccae* (F.Muell.) Domin, *Linospadix apetiolata* Dowe & A.K.Irvine and *Morinda podistra* Halford & A.J.Ford. Altitudinal range, from existing specimens, is 1000–1090 m.

Hollandaea porphyrocarpa has only been collected in RE7.12.20.

***Phenology*:** Flowers have been recorded in May, June, September and October; fruits have been recorded in December.

***Notes*:** The commonly recorded cauliflorous inflorescences make this species unmistakable in the field. This is one of only three proteaceous species in the tropical rainforests of northern Queensland to have this feature.

The perianth is rosy pink in bud and at anthesis; the style is violet at the base and the apex, whilst the mid sections are white; hypogynous glands are creamish yellow and the ovary is purple. New leafy growth is recorded as being green.

The flowers have a slight sweet scent and Bridled Honeyeaters (*Lichenostomus frenatus* (Ramsay)) have been observed visiting them.

***Affinities*:** *Hollandaea porphyrocarpa* appears to be most closely related to *H. sayeriana*, in that they share a smooth fruit surface, abaxial tepal surface clothed in medifixed hairs and a relatively high ovule number. *H. porphyrocarpa* can be distinguished from *H. sayeriana* on the following features: leaf base (attenuate versus cuneate, respectively), smaller fruit (35–45 mm versus 60–150 mm), smaller seeds (13–16 mm versus [12–] 20–30 mm), shorter conflorescence axis (52–103 mm versus 150–380 mm) and longer anthers (4.5–6 mm versus 2–3.1 mm). Comparisons between all species of *Hollandaea* are provided in **Table 1**.

***Conservation status*:** All existing collections have been made within the World Heritage Area of the Wet Tropics bioregion. *Hollandaea porphyrocarpa* has only been collected in one mountainous area, mostly along a walking track, within the Daintree National Park, west of Mossman. It has a very narrow geographical range, from the Pinnacle Rock Track area south towards the Mossman River (R. Russell, personal communication, 2006), with an extent of occurrence estimated to be less than 30 km^2 and an area of occupancy estimated to be less than 15 km^2 and is considered at risk at this time. An estimate of the size of the single population is not known, but an optimistic guess of less than 300 mature individuals is not extravagant. A thorough search to cover areas away from the walking track is necessary to gain a better understanding of the population size and structure. Nonetheless, due to the extremely narrow distribution and estimated population size we would recommend *H. porphyrocarpa* being listed as "Vulnerable" under the IUCN (2001) as it fulfills the criteria under categories VU, D1 and D2.

***Etymology*:** The specific epithet is derived from the Greek *porphyreos* (purple, dark red) and *carpos* (fruit) and alludes to the unique purple-coloured fruit of this species.

3. Hollandaea riparia B.Hyland, *Fl. Australia* 16: 499 (1995). **Type**: Queensland. Cook District: Timber Reserve 165, Baird Logging Area, Qld, 22 September 1980, *B.Hyland 10626* (holo: CNS; iso: BRI; CANB *n.v.*).

***Illustrations*:** Cooper & Cooper (2004: 414); Hyland (1995: Fig. 139); Nicholson & Nicholson (2000: 38); Hyland *et al.* (2003).

Single or usually multistemmed large shrubs or small trees 4–6 m high, with trunk diameters to 15 cm dbh recorded; buttresses absent. Bark nondescript. Terminal and axillary buds clothed in dark brown, minute medifixed hairs. Branchlets initially slightly angled to terete and glabrous, the angled branchlets becoming terete. Seedlings: cotyledons with peltate base; first leaves alternate, toothed; stem hairy. Juvenile leaves simple, unlobed, prominently to sparsely toothed (or rarely entire). Leaves alternate, petiolate, discolorous, dull or slightly shiny on adaxial surface and very pale to pruinose on abaxial surface; lamina narrow-elliptic or oblong to oblanceolate-obovate, 71–205 × 12–39 mm, base attenuate, apex obtuse-acute with acumen absent; margin flat when fresh and slightly recurved when dry; both surfaces glabrous with occasional dark-coloured medifixed hairs present on midvein on abaxial surface; midvein raised on each surface, more prominent on abaxial surface; venation equally conspicuous on both surfaces, primary venation conspicuous on both surfaces with 6–9 primary lateral veins on each side of midvein. Petioles slightly swollen, 0.5–3 mm long, ± flat on adaxial surface, glabrous or with very rare minute, dark coloured medifixed hairs, appearing to be winged and much longer due to the extremely attenuate nature of the leaf base. Conflorescences ramiflorous or just below the lowest/oldest leaves, composed of 130–198 flowers; conflorescence axis 110–155 mm long, weakly angled (not terete), longitudinally striated (when dry), glabrous. Common bracts narrow-ovate, *c.* 0.8 mm long, glabrous except for one or two long hairs at apex. Floral bracts ovate-lanceolate, *c.* 0.7 mm long, glabrous except for one or two minute hairs at the apex, inserted at base or apex of pedicel. Pedicels terete, 1.9–2.2 mm long, glabrous, paired on a peduncle c. 1 mm long. Tepals 28–32 mm long and clavate at apex in mature bud, splitting proximally at first with individual tepals coiling and reflexed at anthesis, apex acute, purplish to purple-green-bluish, glabrous on abaxial and adaxial surface. Stamens with filaments 0.1–0.3 mm long, inserted *c.* 6 mm from tepal apex; anthers 5.5–6 mm long (including a blunt appendage/mucro of *c.* 0.6 mm long). Hypogynous glands free, the apex with a fringe of finger-like papillae, fleshy. Style 21–25 mm long; pollen presenter 3.2–4.3 mm long; ovary 2.2–2.6 mm long, ovules 6–8, placenta marginal. Fruit leathery on both surfaces, 25–50 mm long × 22–26 mm diameter, asymmetrical, semi-discoid (appearing "half-moon" shaped in side view), deeply wrinkled (verrucose), green and pruinose, style persistent. Seeds smooth or angular, 2–8 per fruit, 14–20 mm long on the longest axis, testa thin, radicle *c.* 1.2 mm long. Germination hypogeal. **Fig. 3**.

***Additional specimens examined*: Queensland.** Cook District: Roaring Meg Creek, Oct 1984, *Sankowsky s.n.* (CNS); T.R. 165 Roaring Meg Creek, Apr 1997, *Ford 1887* (BRI, CNS); *loc. cit.*, Nov 1996, *Ford 1808* (BRI, CNS); T.R. 165 Alexandra L.A, Jun 1977, *Hyland 9390* (CNS); T.R. 165 Noah Alexandra L.A, Roaring Meg Creek, Oct 1997, *Ford 2002* (CNS); T.R. 106 Parish of Noah Baird L.A, Roaring Meg Creek, Jul 1997, *Hyland 26019RFK* (CNS); *loc. cit.*, Jul 1997, *Hyland 26020RFK* (CNS).

***Distribution and habitat*:** *Hollandaea riparia* is endemic to the Wet Tropics bioregion in north-eastern Queensland, where it is currently only known to occur as a rheophyte in the Roaring Meg Creek catchment (south of Cooktown) (**Map 1**). It inhabits the riparian zone of creek sides in notophyll-mesophyll vine-forests/rainforests on alluvial soils derived from granite. The dominant canopy species is *Xanthostemon chrysanthus* (F.Muell.) F.Muell. ex Benth. Other canopy species include *Acmena hemilampra* (F.Muell. ex F.M.Bailey) Merr. & L.M.Perry subsp. *hemilampra*, *Blepharocarya involucrigera* F.Muell., *Buckinghamia ferruginiflora* Foreman & B.Hyland, *Gymnostoma australiana* L.A.S.Johnson, *Ormosia ormondii* (F.Muell.) Merr. and *Tristaniopsis*

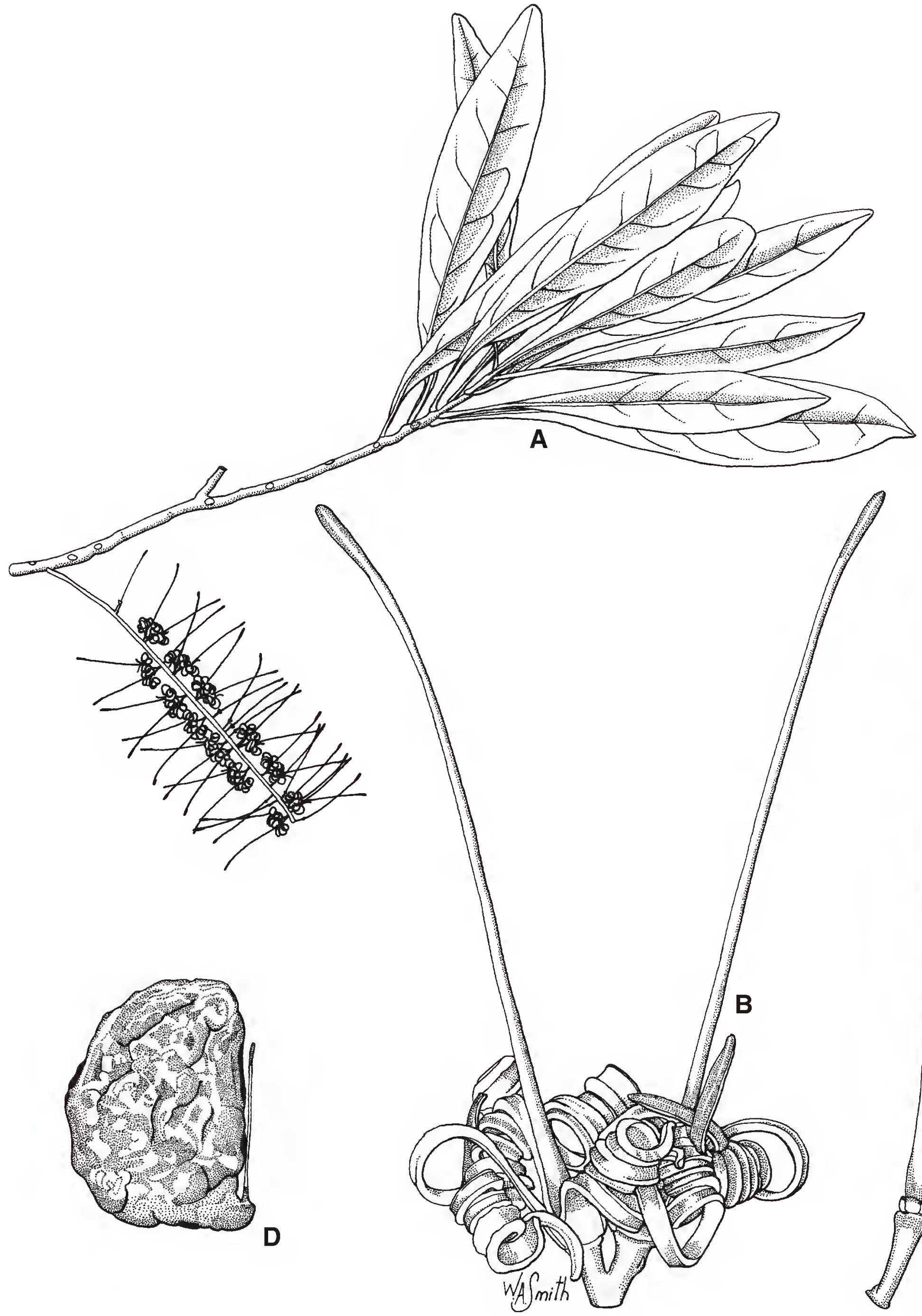


Fig. 3. *Hollandaea riparia.* A. branchlet with inflorescences ×0.4. B. paired flowers at anthesis showing floral bracts ×3. C. close up of ovary showing hypogynous glands and floral bract ×3. D. lateral view of fruit with persistent style ×1. A–C from *Ford 1887* (CNS); D from *Ford 2002* (CNS). Del. W. Smith

exiliflora (F.Muell.) Peter G.Wilson & J.T.Waterh. Common small trees and shrubs include *Acronychia acronychioides* (F.Muell.) T.G.Hartley, *Chionanthus ramiflorus, Choriceras majus* Airy Shaw, *Diospyros* sp. (Baird LA B.P.Hyland 9374), *Dinghoua globularis* (Ding Hou) R.H.Archer and *Phyllanthus brassii* C.T.White. Altitudinal range, from existing specimens, is 250–350 m.

Hollandaea riparia has been collected in RE7.3.49a (usually) and 7.3.10a (rarely).

***Phenology*:** Flowers have been recorded in April and June; fruits have been recorded from September to November.

***Notes*:** The perianth is recorded as purplish to purple-green-bluish; the style is pale pink to pink-purple; the ovary is pink and hypogynous glands are yellowish. Juvenile leaves and adult leaves are similar.

***Affinities*:** *Hollandaea riparia* appears to be most closely related to *H. diabolica* in that they share the features of ± pruinose abaxial leaf surface, wrinkled/verrucose fruit surface, glabrous abaxial tepal surface and a relatively low ovule number. *H. riparia* can be distinguished from *H. diabolica* on the following features: fruit shape (longer than wide versus ± equidimensional, respectively), smaller seeds (14–20 mm versus 22–25 mm), leaf apex (obtuse-acute versus obtuse-retuse), leaf length:width ratio (>4:1 versus <3.6:1), usually longer conflorescence axis (110–155 mm versus 48–120 mm) and more ovules (6–8 versus 2–4). Comparisons between all species of *Hollandaea* are provided in **Table 1**.

***Conservation Status*:** All existing collections have been made within the World Heritage Area of the Wet Tropics bioregion within Timber Reserve 165. Currently, *Hollandaea riparia* is listed under the *NCA* as *Vulnerable*. It has a very narrow geographical range, with an extent of occurrence estimated to be less than 20 km^2 and an area of occupancy estimated to be less than 5 km^2, and is considered at risk at this time. An approximate estimate of the population sizes is not known, but an optimistic guess of less than 300 mature individuals is neither conservative nor extravagant. Nonetheless, due to the extremely limited distribution and estimated population sizes we agree that *H. riparia* be listed as "Vulnerable" under the IUCN (2001) as it fulfills the criteria under categories VU D1 and D2.

***Etymology*:** The specific epithet is derived from the Latin word *riparius* (the bank of a stream) and alludes to the habitat of this species.

4. Hollandaea sayeriana (F.Muell.) L.S.Sm., *Proc. Roy. Soc. Queensland* 67: 39 (1956); *Helicia sayeriana* F.Muell., *Vict. Naturalist* 3: 93 (1886); *Hollandaea sayeri* F.Muell., *Australas. Chem. Druggist* 2: 173 (1887), *nom. illeg.* **Type:** Queensland. Cook District: Mt Bellenden Ker, *s.dat.*, *W.Sayer s.n.* (holo: MEL).

***Illustrations*:** Williams (1984: 159); Wrigley & Fagg (1991: 404); Nicholson & Nicholson (1994: 41); Hyland (1995: 392); Hyland *et al.* (2003); Cooper & Cooper (2004: 415).

Single-stemmed subcanopy trees to 17 m high, with trunk diameters to 30 cm dbh recorded (but usually much less); buttresses absent. Bark nondescript. Terminal and axillary buds clothed in minute, dark brown medifixed hairs. Branchlets initially slightly angled and clothed in minute red-brown medifixed hairs, becoming terete and glabrous, smooth. Seedlings: first leaves alternate; toothed, stem hairy. Juvenile leaves simple, unlobed, prominently toothed. Leaves alternate, petiolate, discolorous, dull on adaxial and abaxial surfaces, the abaxial surface pale lime-green; lamina broadly elliptic to obovate, 90–260 × (52–)90–171 mm, base cuneate, apex acute-obtuse to acuminate with acumen to 8 mm long; margin flat or slightly recurved, denticulate or rarely entire; abaxial surface glabrescent; midvein raised on each surface, more prominent on abaxial surface, on adaxial surface the midvein is raised proximally and depressed distally; venation equally conspicuous on both surfaces, primary venation conspicuous on both surfaces with 7–10 primary lateral veins on each side of the midvein. Petioles swollen, pulvinate, 2–7 mm long, ± terete, glabrescent. Conflorescences ramiflorous or just below the lowest/oldest leaves, composed of 92–224 flowers; conflorescence axis 150–380 mm long, angled (not terete) when dry, densely clothed in dark brown, medifixed hairs. Common bracts lanceolate, 0.8 mm long, with mostly marginal hairs. Floral bracts lanceolate to ovate, *c.* 0.7 mm long, glabrous except for minute, dark brown marginal hairs, inserted in lower half of pedicel (and usually near base of pedicel). Pedicel terete, 2.9–3.5 mm long, clothed in dark brown medifixed hairs, paired on a peduncle *c.* 1 mm long. Tepals 20–26 mm long and clavate at apex in mature bud, splitting proximally at first with individual tepals coiling and reflexed at anthesis, apex acute, pink, moderately clothed on abaxial surface with hairs as for pedicels, glabrous adaxially. Stamens with free filament tips up to *c.* 0.1 mm long, inserted *c.* 5 mm from tepal apex; anthers 3.1–3.9 mm long (including a mucro of *c.* 0.4 mm long). Hypogynous glands connate, the apex with a fringe of globose papillae, fleshy. Style 17–21 mm long; pollen presenter *c.* 2 mm long; ovary 2.6–3.1 mm long, ovules 12–20, placenta marginal. Fruit leathery (neither fleshy nor woody), 60–150 mm long, 21–43 mm diameter, asymmetrical and somewhat ellipsoidal in shape with one side nearly flat, smooth, green, style persistent. Seeds angular to hemispherical or shortly cylindrical, often many-faced with the abaxial face convex, 3–20 per fruit, 12–30 mm long on the longest axis, testa thin, radicle 1–2 mm long, adaxial surface of cotyledons flat. Germination hypogeal. *Sayers's silky oak.*

Additional selected specimens examined**: Queensland.** COOK DISTRICT: Cucania, Apr 1948, *Stephens 12344* (CNS); Bellenden Ker bottom cable station, May 1996, *Gray 6725* (CNS); The Boulders, on walk to lookout, 7 km (by road) west of Babinda, Jun 1992, *Conn 3635* (BRI, CNS, MEL, NSW); The Boulders, Babinda, Mar 1980, *Jago (R.L.) 415* (CNS); Weinert's Creek Babinda, May 1978, *Jago (R.L.) 89* (CNS); N.P.R. 226, Bellenden Ker, junction of Windin Falls road and Bartle Frere road, Apr 1995, *Jensen 218* (CNS); Old Boonjie road, May 1981, *Foreman 103* (CNS); S.F.R. 310, Windin L.A., Nov 1987, *Hyland 25216RFK* (CNS); *loc. cit.*, May 1982, *Gray 2551* (CNS); Topaz road, Apr 1974, *Stocker 1158* (BRI, CNS); Towalla road, Towalla, May 1993, *Cooper 534 & Cooper* (CNS); S.F.R. 755 Boonjee L.A., Apr 1972, *Hyland 5935* (BRI, CNS); S.F.R. 755, Gosschalk L.A, E.P./34, Nov 1976, *Unwin 125* (CNS); S.F.R. 755, Badgery L.A., Nov 1981, *Hyland 11272* (CNS); Henrietta Creek, Palmerston Highway, Jan 1993, *Cooper 479 & Cooper* (CNS); T.R. 1244 Palmerston, Mar 1979, *Gray 1316* (CNS); S.F.R. 756, Maalan L.A., Jan 1979, *Dansie 20138* (CNS).

Distribution and habitat**:** *Hollandaea sayeriana* is endemic to the Wet Tropics bioregion in north-eastern Queensland, where it is currently known to occur between Mt Bellenden Ker (south of Cairns) and the Innisfail area, including the eastern edge of the Atherton Tableland (**Map 1**). It inhabits very wet mesophyll to (rarely) notophyll vine-forests/rainforests on soils derived from basalt, granite and fine grained metasediments (mudstones). Common canopy species throughout its range include *Alstonia scholaris* (L.) R.Br., *Backhousia bancroftii* F.M.Bailey & F.Muell. ex F.M.Bailey, *Beilschmiedia bancroftii* (F.M.Bailey) C.T.White, *Cardwellia sublimis* F.Muell., *Cryptocarya oblata* F.M.Bailey, *Elaeocarpus ruminatus* F.Muell., *Endiandra bessaphila* B.Hyland, *Ficus pleurocarpa* F.Muell., *Ficus variegata* Blume, *Franciscodendron laurifolium* (F.Muell.) B.Hyland & Steenis, *Myristica globosa* subsp. *muelleri* (Warb.) W.J.de Wilde and *Syzygium gustavioides* (F.M.Bailey) B.Hyland. Common small trees and shrubs throughout its range include *Apodytes brachystylis* F.Muell., *Ardisia brevipedata* F.Muell., *Atractocarpus hirtus* (F.Muell.) Puttock, *Brombya platynema* F.Muell., *Gossia dallachiana* (F.Muell. ex Benth.) N.Snow & Guymer, *Hypsophila dielsiana* Loes., *Irvingbaileya australis* (C.T.White) R.A.Howard, *Psychotria* sp. (Utchee Creek H. Flecker NQNC5313), *Rockinghamia angustifolia* (Benth.) Airy Shaw and *Symplocos hayesii* C.T.White & W.D.Francis. Altitudinal range, from existing specimens, is from near sea-level to 800 m.

Hollandaea sayeriana has been collected or reliably reported in the following REs: 7.8.1a (occasionally), 7.8.2a (commonly), 7.8.12 (rarely), 7.11.1a (rarely), 7.11.12a (occasionally), 7.11.28 (rarely), 7.11.29a (rarely), 7.11.29b (rarely) and 7.12.1a (commonly).

Table 1. Morphological comparison of *Hollandaea* species (fruit and seed features mostly taken from Cooper & Cooper [2004: 413–415])

Characters	*H. diabolica*	*H. riparia*	*H. porphyrocarpa*	*H. sayeriana*
Fruit surface	sculptured	sculptured	smooth	smooth
Fruit colour	orange–green	green	purple	green
Fruit length	40–50 mm	25–50 mm	35–45 mm	60–150 mm
Seed colour	brown	cream/yellow/ green	cream/green	whitish
Seed length	22–25 mm	14–20 mm	13–16 mm	12–30 mm
Seeds per fruit	1–4	2–8	6–9	3–20
Leaf apex	retuse–obtuse	obtuse–acute	acute–acuminate	acute–obtuse to acuminate
Leaf base	attenuate	attenuate	attenuate	cuneate
Leaf length:width	2.6–3.6	4–8	2.5–2.8	1.2–2.2
Pedicel length	2.1–3 mm	1.9–2.2 mm	3–4.5 mm	2.9–3.5 mm
Conflorescence axis length	48–120 mm	110–155 mm	52–103 mm	150–380 mm
Conflorescence axis pubescence	moderately hairy	glabrous	densely hairy	densely hairy
Tepal length	27–33 mm	28–32 mm	26–29 mm	20–26 mm
Tepal condition (abaxial surface)	glabrous	glabrous	clothed in medifixed hairs	clothed in medifixed hairs
Style length	20–24 mm	21–25 mm	16–20 mm	17–21 mm
Ovule number	2–4	6–8	12–16	12–20
Anther length	4–5 mm	4–6 mm	4.5–6 mm	2–3.9 mm
Filament length	0.4–0.8 mm	0.1–0.3 mm	c. 0.4 mm	0–0.1 mm
Hypogynous glands	free	free	connate	connate

Phenology: Flowers have been recorded in April, May, June and October; fruits have been recorded in January, March and November.

Notes: The perianth is pink to purple-red in bud and pink, crimson or purple-pink at anthesis. New leafy growth is recorded as being blue-black or maroon. The flower aroma has been variously described as being: 'sweet like honey', 'sweetly fragrant' and also as 'strongly unpleasant'.

Affinities: *Hollandaea sayeriana* appears to be most closely related to *H. porphyrocarpa* in that they share a smooth fruit surface, abaxial tepal surface clothed in medifixed hairs and a relatively high ovule number. *H. sayeriana* can be distinguished from *H. porphyrocarpa* on the following features: leaf base (cuneate versus attenuate, respectively), larger fruit (60–150 mm versus 35–45 mm), larger seeds ([12–] 20–30 mm versus 13–16 mm), longer conflorescence axis (150–380 mm versus 52–103 mm) and shorter anthers (2–3.1 mm versus 4.5–6 mm). Comparisons between all species of *Hollandaea* are provided in **Table 1.**

Conservation status: Most existing collections have been made in Wooroonooran National Park which is within the World Heritage Area of the Wet Tropics bioregion. Currently, *Hollandaea sayeriana* is listed under the *NCA as Near Threatened*. It is estimated to have an extent of occurrence of 1100 km^2 and an area of occupancy of 620 km^2. We recommend *H. sayeriana* being retained as *Near Threatened* as it fulfills the criteria under categories *Near Threatened* A, E and possibly C. We feel it would be premature to suggest a "Near Threatened" status under the IUCN guidelines, even though it may well be, as it is unlikely that it would qualify for any higher status in the future given that there is no evidence to support either the necessary population sizes or number of populations or any decline under any of the other necessary criteria.

***Etymology*:** The species is named for W.A. Sayer, a 19th century Australian naturalist, botanical collector and collector of the type specimen.

Excluded names

Hollandaea lamingtoniana F.M.Bailey, *Queensland Agric. J.* 5:390 (1899) = *Helicia lamingtoniana* (F.M.Bailey) C.T.White ex L.S.Sm.

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Nomenclature and synonymy of several *Goodenia* R.Br. (Goodeniaceae) species from northern Australia

Ailsa E. Holland

Summary

Holland, A.E. (2012). Nomenclature and synonymy of several *Goodenia* R.Br. (Goodeniaceae) species from northern Australia. ***Austrobaileya* 8(4): 688–695.** The nomenclature, characters and morphological variation for several species of *Goodenia* from the Northern Territory and Queensland are investigated, and the names *G. paludicola* Carolin and *G. heteroptera* (F.Muell.) B.D.Jacks. are newly recorded as synonyms of *G. minutiflora* F.Muell. and *G. pilosa* (R.Br.) Carolin respectively. New amended descriptions are provided, along with notes on identification and conservation.

Key Words: Goodeniaceae, *Goodenia*, *Goodenia heteroptera*, *Goodenia minutiflora*, *Goodenia paludicola*, *Goodenia pilosa*, threatened species, Queensland flora, new synonym

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Introduction

Goodenia paludicola Carolin and *G. heteroptera* (F.Muell.) B.D.Jacks. are currently listed as **Near Threatened** under Queensland's *Nature Conservation Act 1992*. These two species have been difficult to distinguish from *G. minutiflora* F.Muell. and *G. pilosa* (R.Br.) Carolin respectively, based on the available literature. These species all occur in the seasonally wet areas of northern Queensland (Qld), and in the northern part of the Northern Territory (NT). Ephemerals in these areas plus adjacent parts of Western Australia (WA), have previously been poorly collected due to inaccessibility during the wet season. The taxonomic and conservation status of these species is here re-examined in light of the many additional herbarium collections now available.

Materials and methods

Diagnostic characters from the literature were examined (Carolin 1990, 1992) and are discussed in light of observations made on the type material, additional specimen collections, and field observations. Type specimens from SYD and MEL, along with the full set of specimens now available at BRI were examined: 22 specimens of *G. minutiflora/G. paludicola* (including one from the NT); and more than 150 specimens of *G. pilosa/G. heteroptera* (including 12 from the NT). Measurements were made by steel ruler or micrometer. Field observations were made in several areas of north Qld.

1. *Goodenia paludicola* Carolin and *G. minutiflora* F.Muell.

The type specimen of *Goodenia paludicola* was designated by Carolin (1990) as "holotype: Queensland: 14 miles (22.4 km) NW of Corinda on road to Westmoreland, *R.C.Carolin 9147*, 7 May 1974 (NSW). Isotype: SYD". This collection was not found in NSW (see acknowledgements). The isotype in SYD is not designated as such, but named "*Goodenia udicola* Carolin" on the label (7.5.1974) and annotated "*Goodenia paludicola* correct name Jan 1989". As the only type material found, this specimen is here designated as lectotype for the name *G. paludicola*. Another cited specimen (*Carolin 8766* [SYD]), was also annotated as "*Goodenia udicola* Carolin" (10.12.1974) and further annotated as "isotype" possibly at a later time, but as this name was never published it can be ignored.

The remaining three specimens cited by Carolin in the protologue of *Goodenia paludicola* (Carolin 1990) are all from the

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NT. These have been re-determined as *G. purpurascens* R.Br. based on the much longer corollas, and are therefore excluded from this study (see acknowledgements).

The lectotype of *Goodenia minutiflora,* designated by Carolin (1990), was also examined "Lectotype: Queensland: Between the Norman and Gilbert rivers, *T. Gulliver 68* (MEL 23997). Isolectotypes: MEL 23998, 22243*" the latter an additional collection by Gulliver from the Norman River. Bentham (1868) fails to mention *G. minutiflora*, although he describes "var. ? *minuta* F.Muell." under *G. purpurascens*, a later synonym (see taxonomy below).

Discussion of characters

Mueller (1874) described *Goodenia minutiflora* as a small herb [8–15 mm] with cauline leaves rarely opposite and then little different to bracteoles, the calyx lobes semi-linear, short, corolla minute [*c.* 3.2 mm], the lobes equal and not winged, seeds many, minute. Carolin (1990, 1992) distinguished his new species *G. paludicola* from *G. minutiflora* by the larger corolla that is deeper in colour, and the auricles on the superior lobes enclosing the indusium.

Peduncles. Carolin (1990, 1992) described the peduncles of *G. paludicola* as "to 3 mm long". The peduncle is normally described as "the part of the stalk below the bracteoles" Carolin (1992: 10). However, in this case it appears that the distance measured is that between the two uppermost bracts (bracteoles) which are subopposite on the stem. The inflorescences (both species) are complex thyrse-like panicles with indeterminate growth, the bracts subtending each new branch initially opposite and then increasingly smaller and offset by up to 3 mm towards the plant apex. The peduncles in this case are correctly interpreted as the distance between the uppermost bracts and the point of branching of the inflorescence directly below. This measurement was observed to be 4–20 mm on the type material of *G. paludicola*.

The peduncles of the type material of *Goodenia minutiflora* and the other specimens examined of this species, were also observed to be 4–20 mm (described as 4–10 mm in Carolin 1992).

Pedicels. The pedicel length for *Goodenia paludicola* was described as 7–9 mm by Carolin (1990, 1992). This does not appear to be correct even for the type material which was observed to have pedicels 3–15 mm long.

The pedicels of the type material of *Goodenia minutiflora* were observed to be 5–16 mm long (described as 5–7 mm by Carolin 1992). The other specimens examined were observed to have pedicel lengths 3–29 mm.

Sepal length. The sepal length for *Goodenia paludicola* is described as 1.5–1.8 mm (Carolin 1990, 1992) but the sepal length observed for the type material was less than 1 mm. The length of sepals for the type material of *G. minutiflora*, along with the majority of specimens examined, was also less than 1 mm, although a number of specimens had slightly longer sepals, up to 1.8 mm long.

Corolla length. Corolla length was used by Carolin (1990, 1992) to distinguish *Goodenia paludicola* (4–5 mm) from *G. minutiflora* (2–3 mm). However, the type material of *G. paludicola* was observed to have corollas 2–3 mm long. The type material of *G. minutiflora* was also observed to have corollas 2–3 mm long, and the corollas of the other specimens examined were observed to be 2–6 mm long. Therefore the species cannot be distinguished by corolla length.

Corolla colour. The deeper corolla colour was one of the characters used to distinguish *Goodenia paludicola* from *G. minutiflora.* Carolin (1990, 1992) describes the corolla colour of *G. paludicola* as bluish-purple, and on the label of the type material it is described as pale purple. Similar specimens collected from the same area as the type of *G. paludicola* had corolla colour described on the labels as purple-red (*Forster PIF20926 & Booth*), white to pale mauve (*Pullen 9123*), or purple (*Thompson WES724 & Hogan*).

The colour of the corolla of *G. minutiflora* was described as purple by Mueller (1874) and "white suffused purple or purplish outside" by Carolin (1992), but corolla colour is not mentioned on the labels of this type material. The corolla colour of additional specimens examined were variously described as white, mauve or red-purple. It is apparent therefore that corolla colour is not a reliable character for distinguishing these two proposed species.

Corolla lobe auricles. *Goodenia paludicola* was distinguished from *G. minutiflora* by "the auricles on the superior lobes enclose the indusium" (Carolin 1990, 1992). The indusia of *Goodenia* species are often enclosed or "sheltered" below the auricles in the early stages of flowering (personal observation) and this is variable on the specimens examined. The "enclosing" of indusia is possibly dependant on the age of the flower or pressing process.

Conclusion

Based on the above observations, the type material of *Goodenia paludicola* appears to represent a small part of the variation apparent across the range of *G. minutiflora* and is therefore here treated as a synonym of that species. The description of *G. minutiflora* is here amended from Carolin (1979, 1990, 1992) to accommodate the additional observed variation.

Taxonomy

Goodenia minutiflora F.Muell., *Fragm.* 8: 244 (1874) **Type:** [Queensland. Cook District:] Between the Norman and Gilbert Rivers, 1874, *T.Gulliver 68* (lecto: MEL, isolecto: MEL, *fide* Carolin [1990]).

Goodenia purpurascens var. *minima* F.Muell. ex Benth., *Fl. Austral.* 4: 78 (1868); *G. minima* (Benth.) Domin, *Biblioth. Bot.* 22: 643 (1929). **Type:** Northern Territory. Upper Victoria R. [River], *s.dat.*, *F.Mueller s.n.* (holo: K *n.v.*; iso: MEL).

Goodenia paludicola Carolin, *Telopea* 3: 536 (1990), **syn. nov. Type:** Queensland. Burke District: 14 miles [*c.* 22 km] NW of Corinda on road to Westmoreland, 7 May 1974, *R.C.Carolin 9147* (lecto: SYD, here designated).

Slender annual herb ascending to 25 cm tall. Stems and pedicels with sparse patent hairs to 0.7 mm long, mixed with shorter glandular hairs. Leaves linear to oblanceolate, entire or with a few teeth, 1–11 cm long, 1–10 mm wide, acute at apex, tapered at base, glabrous or nearly so. Inflorescences comprising compound, leafy thyrse-like panicles, each branch subtended by a reduced leaf-like bract, the bracts sub-opposite below, becoming smaller and more distant, separated by up to 3 mm towards the apex. Bracts mostly linear, 1–35 mm long; peduncles 4–20 mm long; pedicels 3–28 mm long, articulate *c.* 1 mm below the ovary. Sepals partly adnate to the ovary, lanceolate to ovate, acute, 0.5–1.8 mm long, pubescent with simple and glandular hairs. Corolla 2–6 mm long, white, mauve, purple or red-purple; outer surface with simple patent hairs and shorter glandular hairs; inner surface glabrous, without enations; anterior pouch obscure. Corolla lobes with wings *c.* 0.5 mm long and wide; abaxial lobes 1–1.5 mm long; adaxial lobes 1.5–2 mm, the auricle + wing *c.* 1 mm long. Stamen filaments 1–1.5 mm long; anthers *c.* 0.3 mm long. Ovary glandular pubescent; septum nearly as long as loculus; ovules numerous; style to 3 mm long, with scattered patent hairs in the upper part; indusium somewhat oblong, widening at the top, 0.3–0.5 mm long, glabrous below, orifice bristles longer on upper lip, very short on lower lip. Fruit ovoid, 2–4 mm long, covered with patent simple hairs, sometimes mixed with shorter glandular hairs; 2-valved, the valves entire. Seeds slightly biconvex, elliptic, 0.3–0.4 mm long, smooth, glossy, with a narrow rim to 0.1 mm.

***Additional selected specimens examined*: Northern Territory.** 17.9 km from Borroloola T-junction, towards Wollogorang, Jun 1999, *Bean 15116* (BRI, DNA, MEL). **Queensland.** Burke District: Upper Cliffdale Creek area, *c.* 23 km NW of old "Corinda" Outstation on the Doomadgee – "Westmoreland" Road, May 1974, *Pullen 9123* (AD, BRI, CANB, HO, MEL); 49 km from Doomadgee on Hells Gate Road, May 1997, *Forster PIF20926 & Booth* (BRI); Bowthorn Station, 31.5 km NNE of Bowthorn homestead, Jun 2006, *Thompson WES724 & Hogan* (BRI); 4 miles [6.4 km] N of Maggieville on Myravale Road, May 1974, *Carolin 8766* (SYD); Melville Creek, on road N of Normanton, May 2004, *McDonald KRM2306 & Covacevich* (BRI); 10 km along the Normanton to Mogoura Road, SW of Normanton, Apr 1974, *Pullen 8851* (BRI, CANB); 31.1 km by road W of Croydon, Apr 2009, *McDonald*

KRM8388 (BRI); 27.1 km along Claraville Station Road from Croydon, Apr 2007, *McDonald KRM6490* (BRI). Cook District: 140.7 km along Chillagoe Road from junction with Normanton – Karumba Road, May 2004, *McDonald KRM 2325 & Covacevich* (BRI); 13 km along Forsayth Road from Georgetown, Mar 2008, *McDonald KRM7471* (BRI, NSW).

***Distribution and habitat*:** *Goodenia minutiflora* is distributed across northwestern Qld from Croydon to the Borroloola area in the NT. Plants occurs on the edges of lagoons, creeks, and wet depressions, drainage lines or soaks and on clay or sand plains, often associated with *Melaleuca* or *Eucalyptus* and *Corymbia* dominated open woodlands.

***Affinities*:** *Goodenia* species that are morphologically similar and with pink, purple or white flowers are: *G. purpurascens* R.Br. (NT, WA & Qld), *G. viscidula* Carolin (NT & Qld) and *G. gloeophylla* Carolin (NT & WA). However, *G. gloeophylla* and *G. viscidula* are both viscid glandular plants and *G. purpurascens* has longer corollas 8–12 mm long (Carolin 1992).

***Phenology*:** The species is an ephemeral herb appearing between March and June after rain.

***Conservation status*:** A widespread species (currently **Least Concern**), potentially threatened in some areas by weed/pasture invasion of habitat.

2. *Goodenia heteroptera* (F.Muell.) B.D.Jacks. and *Goodenia pilosa* (R.Br.) Carolin

Goodenia heteroptera has been known only from the holotype collected in the Newcastle Range in northern Qld (*W.E.Armit 377* [MEL 68192]) (Carolin 1979; 1992). The more widespread and variable *G. pilosa*, originally described from an island in the Gulf of Carpentaria, has been considered to occur widely across northern Qld and the northern part of the NT, as well as New Guinea, Indonesia, China and the Philippines (Carolin 1979, 1992; AVH 2012).

Discussion of characters

Mueller (1876) distinguished *Goodenia heteroptera* by the pedicels several times shorter than the calyx, and the very small yellow corolla with short superior lobes with unequal wings, a trifid style and wingless seeds (Mueller did not mention *G. pilosa*). Brown (1810) described *G. pilosa* as a herbaceous pilose annual, the leaves dentate or incised, with basal auriculate flowers on axillary, ebracteate one flowered peduncles, the fruit reflexed. Bentham (1868) also described *G. pilosa* but failed to mention *G. heteroptera*.

Carolin (1979) distinguished *Calogyne heteroptera* from *C. pilosa* by the presence of glandular hairs. He also described three races of *C. pilosa* (**Table 1**). Carolin (1992) further distinguished *Goodenia heteroptera* by the length of the corolla (*c.* 6 mm long), the presence of glandular hairs on the corolla, the sinus between the auricle and the wing on the adaxial corolla lobes, and the wing above the auricle narrower than the opposite one. Both descriptions of this species are based entirely on the holotype.

***Habit*.** The holotype of *Goodenia heteroptera* consists of a single small rosette. This material represents an early rosette stage of development only. *Goodenia* species occurring in ephemeral wetlands in northern Australia commonly complete their life cycle quickly by flowering at an early stage, and then if suitable conditions persist, further growth and inflorescence development occurs.

The type material of *Goodenia pilosa* includes several plants with considerable stem development; however, all stages from rosette to trailing stems have been observed among the specimens examined. Carolin (1979, 1992) also described a variety of habits for *G. pilosa* in his races (**Table 1**).

***Hair type*.** The presence of glandular hairs was one of the characters distinguishing *G. heteroptera* (Carolin (1979, 1992) and these are present on the holotype. However, plants with or without glandular hairs were observed to be otherwise indistinguishable on the specimens examined. It is probable that these glandular hairs are more common on specimens collected at moist sites (e.g. *McDonald KRM321*, *Clarkson 8979*) and may even be lost as the environment dries out. Carolin (1992) also described this situation for

Table 1. Forms of *Goodenia pilosa* as described by Carolin (1990, 1992)

	Race A = form i	Race B = form ii	Race C = form iii
distribution	Arnhem Land, NT	Arnhem Land, NT	north Qld
habit	sprawling	compact	sprawling
leaf indumentum	conspicuously hirsute	almost glabrous	few hairs
pedicels	well developed	short, to 4 mm	usually more than 4 mm
corolla hair outside	hirsute-pubescent	few simple hairs	hirsute-pubescent
seed surface	glossy, smooth	prominently verrucose	verrucose to almost smooth in centre

G. purpurascens, where the plants growing in creek beds are more glandular hairy.

Hair density. The holotype of *Goodenia heteroptera* has leaves with sparse hairs, described by Carolin (1979) as “scattered’ while the type material (MEL 68195) of *G. pilosa* is quite hairy. However, hair density was observed to be quite variable across the range on the specimens examined, with those from the NT usually more densely hairy, (along with the type material of *G. pilosa*) although Carolin’s race “B” from Arnhem Land was described as “almost glabrous”.

Leaf length and width. The holotype of *Goodenia heteroptera* has only small rosette leaves, commonly found on immature material across the range. Most mature specimens from north-west Qld and the NT were observed to have longer, more narrow leaves similar to the type material of *G. pilosa*; however, leaf shape varied continuously from north-east Qld to the NT.

Pedicel length. The very short pedicel length was one of the characters used by Mueller (1876) to distinguish *Goodenia heteroptera* and the holotype was observed to have short pedicels *c*. 1 mm long. Carolin (1979, 1992) described the pedicels of *G. heteroptera* as “scarcely 5 mm long” and those of *G. pilosa* as “2–2.5 mm” (although race “C” is described with pedicels more than 4 mm long). The pedicel length observed on the specimens examined varied continuously from 1–22 mm long, suggesting that the measurement given by Carolin is an error and should read “2–25 mm”.

Corolla length. Corolla length was one of the characters used by Carolin (1979, 1992) to distinguish *G. heteroptera* (*c*. 6 mm long) from *G. pilosa* (8–15 mm long). The holotype of *G. heteroptera* has one small flower in the packet, the corolla measuring 6.5 mm long. Corolla length was observed to vary from 6 to 13 mm for the other specimens examined, with corollas tending to be longer on specimens from the NT (10–13 mm).

Wing above the auricle. The unequal wings on the superior (adaxial) lobes was mentioned by Mueller (1974), Bentham (1868) and Carolin (1979, 1992) as a distinguishing character for *Goodenia heteroptera*. Carolin also described the presence of a sinus between wing and auricle, as an additional distinguishing character. On all specimens examined, the wing above the auricle is shorter, and the wing-auricle boundary is not clear cut. It was observed to be either seamless, folded or broken on various specimens. The appearance of a sinus on the holotype of *G. heteroptera* is therefore probably a misinterpretation of folding in the transition zone where it joins to the more rigid auricle. In the field, the auricles of *G. pilosa* together form an “umbrella” over the indusia during the early stages of flowering, and a fold or sinus probably develops as the flower ages, or during pressing.

Seed surface. Carolin (1990, 1992) describes *Goodenia heteroptera* as having a verrucose-granular seed surface and *G. pilosa* as having both smooth (race A) or verrucose surfaces (races B and C). The holotype of *G. heteroptera*, along with most of the eastern Qld material has verrucose seeds, sometimes very faintly so, or verrucose with an almost smooth centre, representing transitional states (e.g. *Wannan 3534*, *Clarkson 8979*, *Bean 16419*). The type material of *G. pilosa* has smooth seeds.

Conclusion

I conclude that the holotype of *Goodenia heteroptera*, though flowering and fruiting, represents an early rosette stage of development, and represents just one part of the variation of the variable and widespread *G. pilosa*. The type specimen corresponds most closely with Carolin's Race B from Arnhem Land (Carolin 1979), but the variability across the range does not support formal recognition of these races. Specimens examined from north-west Qld and the NT usually have longer, more narrow leaves, denser indumentum and longer corollas (Race A), but these characters vary across the range of specimens examined. The name *G. heteroptera* is therefore treated as a synonym of *G. pilosa* and the description of *G. pilosa* is amended from Carolin (1979, 1992) to accommodate the corrections and additional observed variation.

Taxonomy

Goodenia pilosa (R.Br.) Carolin, *Telopea* 3: 365 (1990); *Calogyne pilosa* R.Br., *Prodr.* 579 (1810); *Goodenia dubia* Sprengel, *Syst. Veg.* 1: 271 (1824), *nom. illeg.* **Type:** Northern Territory. Carpentaria, island no. 12 [North Is., Sir Edward Pellew Group,], 16 December 1802, *R.Brown s.n.* (lecto: BM *n.v.*; isolecto: K [photo!], MEL, *fide* Carolin [1979: 5]).

Balingayum decumbens Blanco, *Fl. Filip.* 187 (1837). **Type:** not designated.

Calogyne chinensis Benth., *J. Linn. Soc., Bot.* 5: 78 (1861). **Type:** China. near Amoy [Xiamen], *s,dat., H.F.Hance 1422* (holo: K, photo!, *fide* Carolin [1992: 275]).

Calogyne heteroptera F.Muell., *Fragm.* 10: 43 (1876); *Goodenia heteroptera* (F.Muell.) B.D.Jacks., *Index Kew.* 1: 1056 (1895), **syn. nov.**; Carolin, *Telopea* 3: 565 (1990), *nom. superfl.* **Type:** Queensland. COOK DISTRICT: Newcastle Ra. [Range], *s. dat., W.E.Armit 377* (holo: MEL).

Prostrate annual, initially a rosette to 5 cm high, later seasonal growth spreading with prostrate stems to 50 cm long. Plants sparsely to moderately pilose with translucent hairs to 1.5 mm long, spreading or oblique, sometimes mixed with smaller glandular hairs particularly on lower leaves, stems and sepals. Leaves sessile, variable in shape, obovate to lanceolate or linear, acute, broadly acute or rounded at apex; margins entire or shallowly and distantly dentate, sparsely hirsute mainly on the margins and midvein. Basal leaves obovate, tapered at base, 1–4(–8) cm long, 0.3–1 cm wide; cauline leaves alternating on stem, oblanceolate to nearly linear, to 15 cm long, and up to 1 cm wide, base tapered or auriculate with several spreading lobes. Racemes to 35 cm long, the flowers subtended by leaf-like bracts, and often clustered near the apex; pedicels 1–22 mm long, sparsely pilose, not articulate, bracteoles absent. Sepals attached just below the top of the ovary, lanceolate to narrowly oblong, 2.2–5 mm long, ciliate. Corolla 7–15 mm long, pale yellow with brown or red stripes; outer surface sparsely pilose; inner surface hairy in throat, without enations or pouch; abaxial corolla lobes 3–5 mm long, wings 1–1.5 mm wide, extending 1/2 to 2/3 of the lobe; adaxial lobes 3–7 mm long, the auricle well developed, *c.* 1.5 mm long and wide, and joined to wing on that side, sometimes with a fold or shallow sinus between; wings ± equal, 1–1.5 mm long and wide. Ovary pilose, sometimes shorter glandular hairs also present; septum short; ovules 10–15; style 3-fid, the middle indusium shorter, semicircular, *c.* 0.5 mm long. Fruit subglobular, 2.5–5 mm diameter, valves persistent, gaping. Seed pale brown, ovate to elliptic with a prominent rim, 2–4.5 mm long, smooth to verrucose, wing absent.

***Additional selected specimens examined*:** **Northern Territory.** English Company Islands, Cotton Is., Jul 1992, *Leach 3102* (BRI, DNA, K); E side Mt Norris Bay, Oct 1992, *Cowie 3246* (BRI, DNA, MEL); Kakadu N.P., Jaribu East near Aerodrome, May 1988, *Weber 9680* (AD, BRI); Yirrkala, Aug 1948, *Specht 913* (BRI, DNA); Echo Is., Ritjirriur Swamp, Jul 1975, *Latz 6124* (BRI, CANB, DNA, L, NSW). **Queensland.** BURKE DISTRICT: Eight Mile Yard W of Doomadgee Aboriginal Mission Station near Nicholson River, May 1974, *Pullen 9071* (BRI, CANB); 9.1 km (by road) ENE of Musselbrook mining camp on Musselbrook Creek, 175 km N of Camooweal, Lawn Hill N.P., Apr 1995, *Johnson MRS526 & Thomas* (BRI); Clara River, 40.3 km along Richmond Road from Prospect Station turnoff, Mar 2008, *McDonald KRM7584A* (BRI). COOK DISTRICT: Thursday Island near satellite receiving dishes on Milman Hill, Apr 1986, *Clarkson 6456* (BRI, NSW); 58.7 km N of the Archer River crossing on the Coen to Weipa Road, Apr 1991, *Clarkson 8979 & Neldner* (BRI, NSW); 3 km E of junction of Kennedy River & Lakes Creek, Lakefield N.P., May 1992, *Neldner 4012* (BRI); Isabella Falls 23.5 km E of Normanby River on Laura to Cooktown Road, Jun 1985, *Clarkson 5968* (BRI, CANB, DNA, L, PERTH); Hann Tableland N.P., headwaters of Gap Creek, central part of Tableland, W of Mareeba, May 2010, *Forster PIF37250 & Thomas* (BRI, MEL); 150 metres from Rookwood Creek, Rookwood Station, Mar 2000, *McDonald KRM321* (BRI); 51.3 km along O'Briens Creek Road from Mount Surprise, Mar 2007, *McDonald KRM6348* (BRI); Fog Creek Station, *c.* 1.2 km W of Fog Creek, about 21 km N of the homestead, 180 km N of Richmond, Apr 2004, *Kahler TH7910 & Appelman* (BRI). NORTH KENNEDY DISTRICT: S of Cardwell, May 2004, *Wannan 3534* (BRI); Doug Haigh Drive, NE of Ravenswood, Apr 2010, *Holland 2068 & Lovatt* (BRI, DNA); Lannercost S.F., Oak Hills Road, W of Ingham, May 2003, *Ford AF3954* (BRI, MEL, NSW); Bruce Highway, 13 km W of Bowen, May 2000, *Bean 16477* (BRI, MEL); 2.9 km along Airport Road, S of Proserpine, May 2000, *Bean 16419* (BRI). SOUTH KENNEDY DISTRICT: 24.3 km from Proserpine towards Mackay, Apr 1991, May 2000, *Bean 2902* (BRI); Ilbilbie – Notch Point Road, *c.* 4 km due W of coast, Apr 1994, *Champion 1056 & Pollock* (BRI).

***Distribution and habitat*:** *Goodenia pilosa* is distributed across northern Australia, from Mackay to Cape York in Qld, and across the top end of the NT (AVH 2012); also in New Guinea, Indonesia, China and the Philippines. It occurs in seasonally wet areas, on the edges of lagoons, creeks, and wet depressions, drainage lines or soaks, on clay or sand plains, often associated with *Melaleuca* or *Eucalyptus* and *Corymbia* open woodland.

***Affinities*:** *Goodenia* species that are similar to *G. pilosa* and that have yellow flowers and branched styles are *G. holtzeana* (Specht) Carolin (NT & WA), *G. heppleana* (W.Fitzg.) Carolin (NT & WA) and *G. neglecta* (Carolin) Carolin (NT). However, *G. holtzeana* is an erect, viscid herb with longer corollas (14–20 mm long); *G. heppleana* is also glandular but is distinguished by the fruit which do not gape open at maturity. *Goodenia neglecta* is the most similar to *G. pilosa*, but can be distinguished by the glandular hairy bracts and pedicels (Carolin 1992).

***Phenology*:** *Goodenia pilosa* is an ephemeral herb appearing between March and June after rain.

***Conservation status*:** A widespread and common species (currently **Least Concern**), potentially threatened in some areas by weed/ pasture invasion.

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Many thanks go to Keith McDonald (formerly of the Department of Environment & Heritage Protection) whose untiring collection efforts have made this investigation possible. I also wish to thank Murray Henwood (SYD) and Dale Dixon (NSW) for searching for type material of *G. paludicola*; Pina Milne (MEL) for the loan of type material of *G. heteroptera*, *G. pilosa* and *G. minutiflora*; and Ian Cowie (DNA) and Dave Albrecht (NT) for finding and measuring the three Northern Territory specimens cited by Carolin (now re-determined as *G. purpurascens*).

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SHORT COMMUNICATION

Types of enigmatic north-Queensland Orchids from the Dockrill herbarium

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Alick William Dockrill (1915–2011), author of the classic work *Australian Indigenous Orchids* (Dockrill 1969, 1992) donated his personal orchid herbarium of approximately 1600 specimens to the Australian National Herbarium – Atherton (QRS) which is now integrated with the Australian Tropical Herbarium – Cairns (CNS). A number of duplicates of types have been recovered from this material including those for five poorly known taxa: *Dendrobium masonii* Rupp, *Dendrobium baseyanum* St.Cloud, *Dendrobium* × *foederatum* St.Cloud, *Eria intermedia* Dockrill and *Oberonia attenuata* Dockrill. These five taxa are enigmatic because they have not been re-recorded in the wild at or near their type localities since they were described and also because two of them are considered to be extinct in the wild under State and Commonwealth legislation.

We review the status of these five type specimens and provide a current interpretation as to their correct taxonomic placement. All specimens have been seen unless indicated as n.v. Accepted names are given in **bold** type. Type specimens originally accessioned at QRS are cited with their QRS numbers, whereas the recent duplicates are accessioned with CNS numbers.

1. Dendrobium masonii Rupp, *Austral. Orchid Rev.* 18: 18 (1953); *Diplocaulobium masonii* (Rupp) Dockrill, *Orchadian* 1(11) (1965). **Type citation:** "Cape Tribulation, North Queensland, 1950, W.W. Mason, Junr.; flowering in Sydney, N.S.W., in early November, 1952". **Type:** Queensland. Cook District: Cape Tribulation, 1950, *W.W.Mason s.n.* (holo: NSW 22393, *fide* M.A. Clements 8 May 1986; iso: CNS 137337 ["conveyed by St Cloud" hand written on Dockrill's original folder]).

Dendrobium masonii Rupp has not been re-recorded in the wild since it was described, despite subsequent exploration of the type locality (Lavarack & Gray 1985). Dockrill (1992) reported that the type locality had been cleared for grazing whereas B. Gray (pers. comm.) reported that the host tree for the plant from which the type specimen was prepared had fallen into Bailey Creek.

Upon accessioning the Dockrill herbarium a duplicate of the W.W. Mason Jnr. collection was located (CNS 137337).This specimen appears to be the basis of the habit illustration in Dockrill (1965), whereas the flowers in the illustration appear to have been redrawn from Rupp's original 1952 figure (Dockrill 1992). Dockrill's specimen is annotated as having been 'conveyed by S.F. St Cloud' who was one of Rupp's correspondents, known to Rupp as his 'Cairns huntsman' (Gilbert 1992).

Rupp recorded the type as having been sent to him by W.W. Mason Jnr. from Cape Tribulation in 1950 as a sterile living plant which he presumed was a *Bulbophyllum* (Rupp 1953). Rupp lodged the living material at the Sydney Botanic Gardens glasshouse in 1951; it was sent on to Mr & Mrs Loader of Castlecrag in 1952 and then returned to Rupp when it flowered (Rupp 1953). The holotype

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is therefore a fifth-hand collection that passed through several glass-house collections of cultivated plants. This raises the possibility that a mix-up occurred in cultivation and that this taxon is a spurious record for Australia.

Dendrobium masonii was transferred to the genus *Diplocaulobium* by Dockrill (1965) and is currently considered to be a synonym of *Diplocaulobium stelliferum* (J.J.Sm.) A.D.Hawkes from Malesia (Lavarack *et. al.* 2000). The species is considered to be extinct in Australia.

It is possible that W.W. Mason Jnr. supplied Rupp with a specimen of a similar orchid such as *Abaxianthus convexus* (Blume) M.A.Clem. & D.L.Jones, a species that is abundant at the type locality but was relatively unknown in Australia at the time *D. masonii* was described. Specimens collected by W.W. Mason Jnr and A.W. Dockrill when they returned to the type locality in 1962 clearly belong to *A. convexus* (CNS 137455 & CNS 137456).

2. Dockrillia baseyana (St.Cloud) Rauschert, *Feddes Repert.* 94: 446 (1983); *Dendrobium baseyanum* St.Cloud, *N. Queensland Naturalist* 23(110): 1 (1955). **Type citation:** “Type in North Queensland Herbarium, Cairns. Habitat, Kings Plains [south west of Cooktown], N.Q. Coll. *F.L. Basey s.n.*” **Type:** (holo: QRS ex CAIRNS, not found; iso: CNS *ex* Dockrill herbarium, destroyed; lecto: ‘Kings Plains, North Queensland’, F.L. Basey *s.n.* original illustration, *fide* Clements (1989: 46).

The F.L. Basey holotype of *Dendrobium baseyanum* St. Cloud said to be at CAIRNS (integrated into QRS in 1971, now integrated into CNS) was reported missing by Clements (1989) who nominated the original illustration as lectotype. Flowers from the F.L. Basey ‘Kings Plains’ specimen were located in the Dockrill herbarium; however, this duplicate is an insect-destroyed fragment and no material remained that was suitable for a type specimen. Dockrill annotated this specimen that one of the two flowers was inconsistent with the description.

This taxon is currently recognised as a synonym of **Dockrillia calamiformis** (G.Lodd.) M.A.Clem. & D.L.Jones (Clements & Jones 1996).

3. Dockrillia × foederata (St. Cloud) Rauschert, *Feddes Repert.* 94: 446 (1983); *Dendrobium foederatum* St.Cloud, *N. Queensland Naturalist* 23(111): 2 (1955). **Type citation:** “Type in North Queensland Herbarium, Cairns. Growing on *Heritiera littoralis* in mangrove swamp, Aeroglen, near Cairns, leg. J. Dyson-Holland, September, 1954, flowering in cultivation, October 1954 to January 1955.” **Type:** Queensland. Cook District: Aeroglen, Cairns, 28 December 1954, *J.Dyson-Holland s.n.* (holo: QRS 44141; iso: CNS 137336).

The holotype of *Dendrobium foederatum* St.Cloud lacks flower parts and roots. A duplicate of this collection was located in the Dockrill herbarium (CNS 137336). Although this isotype specimen is insect-damaged it includes a number of flowers and roots and thus remains useful for research. A third more complete specimen (CNS 44140) collected by L.J.Brass from cultivation may be descended from the type (i.e. a clonotype).

This taxon is thought to be a natural hybrid between *Dockrillia rigida* (R.Br.) Rauschert and *D. calamiformis* (Lodd.) M.A.Clem. & D.L.Jones (the latter originally as *Dendrobium teretifolium* R.Br. [= *Dockrillia teretifolia* (R.Br.) Brieger] in St Cloud [1955]). The describing author was of the opinion that “evidence is against a natural hybrid” (St Cloud 1955); however, subsequent authors have all listed it as a naturally occurring hybrid species (Rauschert 1983; Clements 1989).

4. Eria intermedia Dockrill, *Austral. Pl.* 120 (1964); *Bryobium intermedium* (Dockrill) D.L.Jones & M.A.Clem., *Orchadian* 15(2): 88 (2005). **Type citation:** “Whitfield Range, North Queensland (A.W. Dockrill 26/12/1961 – Herb. BRI).” **Type:** Queensland. Cook District: Whitfield Rge [Range], 26 December 1961, *A.W.Dockrill s.n.* (holo: BRI [AQ279580]; iso: QRS 129124).

A duplicate of the holotype (QRS 129124) and a cultivated specimen of *Eria intermedia* (CNS 132279) were located in the Dockrill herbarium. These collections all originate from the Dockrill type collection from the Whitfield Range, Cairns on 26 Dec 1961, which remains the only authentic herbarium record of this taxon in Australia.

This taxon is currently recognised as a synonym of **Eria dischorensis** Schltr. (Dockrill 1969), a species that has a distribution primarily in Papua New Guinea, although Jones & Clements (2005) recognised it as *Bryobium intermedium* and endemic to Australia.

5. Oberonia attenuata Dockrill, *N. Queensland Naturalist* 29(126): 4, figs A–I (1960). **Type citation:** "North Queensland, Mossman River 12–6–1960, Leg. A.W. Dockrill". **Type:** Queensland. Cook District: Mossman River, 12 June 1960, *A.W.Dockrill s.n.* (holo: BRI [AQ279632]; iso: CNS 137338).

Oberonia attenuata has not been recollected in Australia since it was described in 1960 and is listed as Extinct under State and Commonwealth legislation. Duplicates of the holotype and two previous unrecorded collections were found in the Dockrill herbarium, greatly adding to the known material of this species. *O. attenuata* is unique among Australian *Oberonia* in having long (up to 160 mm) and narrow (4–8 mm) pendulous falcate-subulate leaves and flowers with a labellum bearing deeply bifid or trifid side and front lobes. The cause of the apparent extinction of this species at the type locality is poorly understood. Further searches for this species are needed over a wider range than previously surveyed.

***Additional specimens examined*: Queensland.** Cook District: Mossman River, Jan 1960, *Archer et al. s.n.* (CNS 137339); Babinda, May 1956, *Wilkie s.n.* (CNS 137340). Additional replicates of these specimens will be distributed to BRI and CANB.

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New species and subspecies of *Ipomoea* L. (Convolvulaceae) from northern Australia and a key to the Australian species

R.W. Johnson

Summary

Johnson, R.W. (2012). New species and subspecies of *Ipomoea* L. (Convolvulaceae) from northern Australia and a key to the Australian species. ***Austrobaileya* 8(4): 699–723.** *Ipomoea bracteolata* R.W.Johnson, *I. densivestita* R.W.Johnson, *I. dunlopii* R.W.Johnson, *I. funicularis* R.W.Johnson, *I. kalumburu* R.W.Johnson, *I. limosa* R.W.Johnson, *I. tolmerana* R.W.Johnson, *I. tolmerana* subsp. *occidentalis* R.W.Johnson and *I. versipellis* R.W.Johnson are described as new species or subspecies. All new taxa are illustrated and notes are given on their distribution, habitat, phenology, affinities and conservation status. A key to all Australian species of *Ipomoea* is provided.

Key Words: Convolvulaceae, *Ipomoea*, *Ipomoea bracteolata*, *Ipomoea densivestita*, *Ipomoea dunlopii*, *Ipomoea kalumburu*, *Ipomoea funicularis*, *Ipomoea limosa*, *Ipomoea tolmerana*, *Ipomoea tolmerana* subsp. *occidentalis*, *Ipomoea versipellis*, Australian flora, identification key, new species, taxonomy

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Introduction

Ipomoea L. is a genus of more than 600 species (Austin & Hauman 1996) found mainly in tropical and subtropical regions, particularly in the Americas. Bentham (1869) listed 38 species in his *Flora Australiensis* treatment, but many have since been transferred to segregate genera such as *Davenportia* R.W.Johnson, *Jacquemontia* Choisy, *Lepistemon* Blume, *Merremia* Dennst. ex Endl. and *Xenostegia* D.F.Austin & Staples. In Australia, there are more than 50 species, including 16 which have become naturalised. Most of the native species are endemic.

This paper has been prepared as a precursor to an account of Convolvulaceae for the *Flora of Australia*. While it covers most of the currently unresolved problems in the genus, both *Ipomoea abrupta* R.Br. and *I. gracilis* R.Br. embrace considerable variation and need more careful study.

Materials and methods

This paper is based mainly on specimens held at BRI and borrowed from DNA and PERTH. Common abbreviations used in the citation of specimens include N.P. (National Park). Abbreviations for Australian states are NSW (New South Wales), NT (Northern Territory), Qld (Queensland), WA (Western Australia), Vic (Victoria).

Taxonomy

Ipomoea bracteolata R.W.Johnson **species nova**; affinis *I. yardiensi* A.S.George, sed caulibus serpentibus et volubilibus (non fruticosis), sepalis multo longioribus, >15 mm longis (non 8–11 mm longis) et bracteolis persistentibus et multo longioribus, 10–15 mm longis (non 2–3 mm longis) differens. Planta perennis, caules serpentes et volubiles. Folia simplicia, lamina ovata usque ad late ovata, integra. Inflorescentia cymosa, 1-flora. Sepala exteriora ovata, acuta, ± laevia. Corolla infundibuliformis taeniis mesopetalinis pilosis. Semina puberula, caespite pilorum longiorum ad hilum. **Typus:** Northern Territory. Darwin And Gulf: near quarry road, Batchelor, (13°02′S 131°05′E), 15 February 1991, *I. Cowie 1384 & P. Munns* (holo: BRI; iso: DNA *n.v.*, MEL *n.v.*).

Ipomoea sp. Cobourg (G.M.Wightman 380); Short *et al.* (2011).

Ipomoea sp. Mt Fyfe (R.L.Barrett & M.D.Barrett RLB 1526); Western Australian Herbarium (2011).

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† Deceased

Perennial with trailing and twining stems; **stems** terete, herbaceous, moderately densely to densely hairy, hairs crisped-appressed to ascending or spreading, 0.7–2 mm long. **Leaves** simple, petiolate; **petiole** 7–20 mm long, 0.13–0.4 times as long as the blade, vestiture as for stem; **blade** ovate to broadly ovate or ovate-oblong, 27–65 mm long, 13–55 mm wide with a length:width ratio of 1.1–2.2, entire, apex obtuse to rounded, rarely sub-acute, with a short mucro, *c.* 0.6 mm long, base rounded to sub-cordate, densely to moderately densely hairy on both sides with semi-appressed to ascending hairs 0.5–2 mm long, midrib with 5–7 pairs of secondary veins, raised below. **Inflorescence** axillary, cymose, 1-flowered; **peduncle** terete, 13–60 mm long, vestiture as for the stem; **bracteoles** opposite, herbaceous, narrowly ovate-lanceolate, sometimes acuminate, 10–20 mm long, 3–6 mm wide, vestiture as for leaves, persistent at flowering and early fruiting, apex acute, mucronulate, attenuate to rounded at base; **pedicels** terete, 5–10 mm in flower, 15–23 mm in fruit, vestiture as for the stem. **Outer sepals** narrowly ovate, ovate-elliptic or lanceolate, 20–25 mm long, 6–10 mm wide in flower, with a length:width ratio of 2.5–3.5, apex acute, mucronulate, attenuate to rounded at base, smooth, moderately densely to densely hairy with hairs up to 2 mm long; **inner sepals** narrowly ovate-lanceolate, 20–25 mm long, 3.5–4 mm wide, apex acute, mucronulate, attenuate to rounded at base, with a hyaline basal margin, moderately densely hairy in the upper part and along the spine. **Corolla** funnel-shaped with a slender tube, pale pink to pale mauve with a darker throat, 50–80 mm long, 35–55 mm diameter; **petals** 65–95 mm long, 25–35 mm wide, lobes rounded, midpetaline band moderately hairy to within 20–40 mm of base of corolla, hairs 0.3–0.8 mm long, mainly appressed, antrorse. **Stamens** included, attached to the base of the corolla for *c.* 20 mm; **filaments** free for 10–15 mm, with multicellular hairs around the point of attachment; **anthers** oblong, sagittate, *c.* 2.8 mm long with basal lobes 0.6–0.7 mm long; **pollen** globular, spinulose. **Ovary** 2-locular, glabrous; **style** 30–40 mm long; **stigma** biglobular. **Capsule** ovoid, *c.* 10 mm long, valvate-dehiscent, glabrous; **seeds** 4, *c.* 7 mm long, dark brown, sparsely to moderately puberulent, with slightly longer hairs, 0.2–0.4 mm long, on the margins and a tuft of long whitish hairs to 1 mm around the hilum. **Fig. 1.**

Additional specimens examined**: Western Australia.** Mitchell Plateau, river plain on Camp Creek below crusher, Feb 1979, *Beard 8323* (BRI); 2 km SW of Mt Fyfe, Drysdale River Station, Jan 2001, *Barrett & Barrett RLB1526* (PERTH). **Northern Territory.** Cobourg Peninsula, Smith Point, May 1983, *Wightman 380* (DNA); Cobourg Peninsula, SE of Port Bremer pearl farm, Feb 2005, *Cowie & Brennan 10440* (DNA); Cobourg Peninsula, track to Observation Cliff, Feb 1994, *Egan 3130* (BRI); Kakadu N.P. on track to Nangalor Gallery, Feb 1991, *Brennan 964* (DNA); near T/O [turnoff] to Batchelor quarry, Mar 1991, *Cowie 1581 & Munns* (BRI, DNA).

Distribution and habitat**:** *Ipomoea bracteolata* occurs in the Drysdale River – Mitchell Plateau area of the Kimberley, Western Australia, in the north western area of the Northern Territory on the Cobourg Peninsula and near Batchelor and Jabiru (**Map 1**). It grows in eucalypt woodland communities, often with *Eucalyptus miniata* A.Cunn. ex Schauer and *Corymbia*, on sandy soils on rocky hills.

Phenology**:** Flowers have been recorded from January to May; immature fruits have been recorded in February.

Affinities**:** *Ipomoea bracteolata* is a rather distinctive species. It resembles *I. yardiensis* in having a corolla with a hairy mid-petaline band but it is a vine with trailing and twining stems, not a shrub. Its bracts are persistent and large, unlike the small bracts of *I. yardiensis* which abscise pre-flowering.

Conservation status**:** It is regarded as a priority 1 taxon in Western Australia (Western Australian Herbarium 2011). It is not listed among the threatened species in the Northern Territory (Short *et al.* 2011).

Etymology**:** The specific epithet is derived from the Latin *bracteola,* meaning a bracteole. This refers to the pair of distinctive bracteoles at the base of the pedicel.

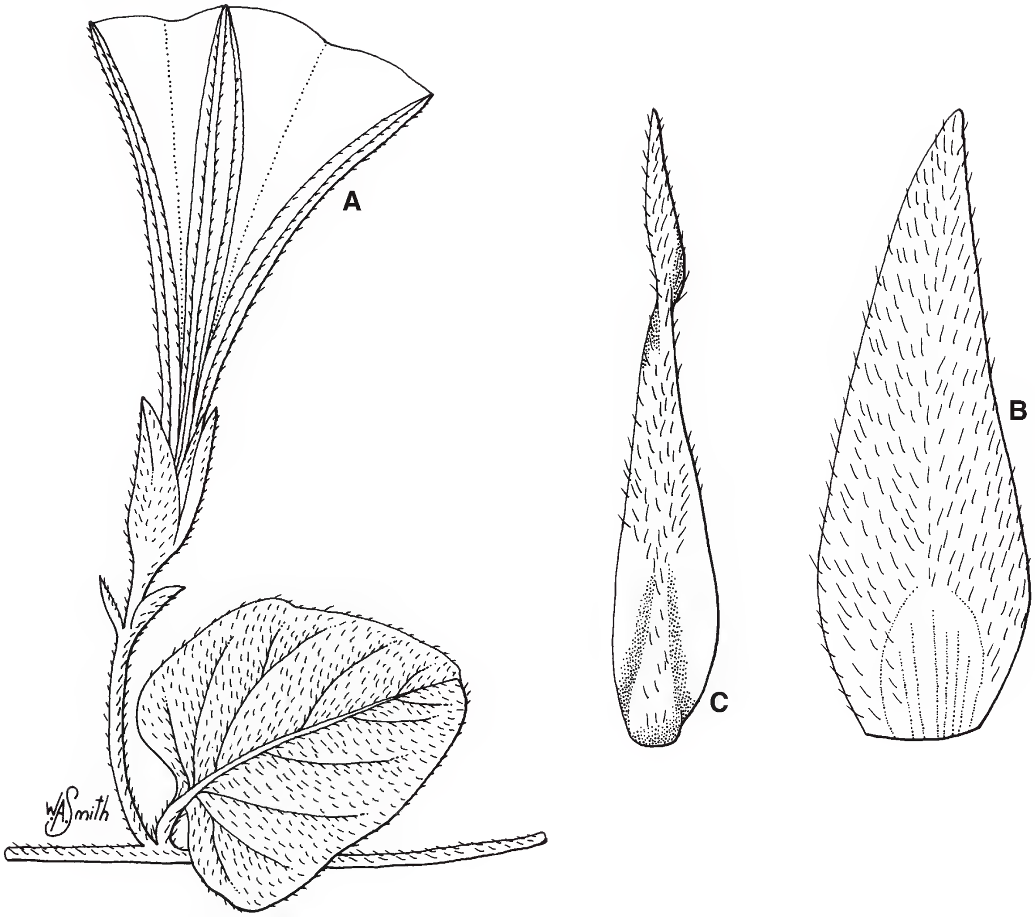

Fig. 1. ***Ipomoea bracteolata***. A. flowering branch × 1. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. A from *Cowie & Brennan 10440* (DNA); B–C from *Barrett RLB1526 & Barrett* (PERTH). Del. W.Smith

Ipomoea densivestita R.W.Johnson **species nova**; affinis *I. abruptae* R.Br., sed seminibus puberulis, pilis longis in marginibus externis (non lanatis) et sepalis pilosis (non glabris) differens. Planta perennis, caules repentes et volubiles. Folia simplicia, lamina late ovata, integra. Inflorescentia cymosa, 1–4-flora. Sepala exteriora ± laevia. Corolla infundibuliformis, glabra. Semina sparsim puberula, pilis longis in marginibus externis. **Typus:** Queensland. Cook District: entrance to Maidenhair Grotto, Chillagoe, 25 January 1984, *M.Godwin C2541* (holo: BRI).

Ipomoea lasiophylla Domin, *Biblioth. Bot.* 89(6): 536 (1928), *nom. illeg., non* Hallier f. (1893). **Type:** Queensland. Cook District: in collibus caraticis apud opp. Mungana, February 1910, *K.Domin s.n.* (holo: PR 530547, photo BRI).

Ipomoea sp. (Mungana L.J.Webb+ 10184); Johnson (2007, 2010).

Perennial vine with trailing and twining stems; **stems** terete, woody at the base, moderately to densely hairy, hairs tubercle-based, simple or bifid, 0.1–0.5 mm long. **Leaves** simple, petiolate; **petiole** 20–70 mm long, 0.35–0.7 times as long as the blade; **blade** broadly ovate to ovate-orbicular, 40–150 mm long, 30–120 mm wide with a length:width ratio of 1.1–1.6, apex obtuse to rounded, sometimes slightly emarginate, mucronulate, base cordate with a narrow sinus to 20% of blade length, densely pubescent on both sides, midrib with a pair of small slit-shaped glands at the base and 9–12 pairs of secondary veins. **Inflorescence** axillary, compound cymose, 1–5-flowered; **peduncle** stout, terete, 5–75 mm long, vestiture as for stem; **bracteoles** opposite, herbaceous, oblong to obovate-oblong, rounded at apex, abscissing prior to flowering; **pedicels** terete, dilated upwards, 10–30 mm long, vestiture slightly less dense than peduncle, with 5 small slit-shaped glands below the calyx. **Outer sepals** concave, broadly ovate, broadly oblong to orbicular, 8–10 mm long, 7–9 mm wide in flower, apex rounded, base rounded, thickened with a narrow hyaline margin, surface smooth, densely to moderately densely hairy, extending to 14 mm × 14 mm at fruiting, becoming bullate and sparsely hairy; **inner sepals** of similar shape and size to inner, hairs restricted to spine. **Corolla** funnel-shaped, with a cylindrical tube, pink to pale purple, midpetaline band and throat darker, 50–60 mm long, 50–60 mm diameter; **petals** to 70 mm long, lobes rounded, emarginate, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for *c.* 14 mm; **filaments** free for 13–16 mm, with multicellular hairs from just below the point of attachment upwards for *c.* 4 mm; **anthers** narrow-lanceolate, sagittate, *c.* 5 mm long and 1 mm wide; **pollen** globular, spinulose. **Ovary** hemispherical, 2-locular, glabrous; **style** *c.* 27 mm long; **stigma** biglobular. **Capsule** globular, 8–11 mm long, with a persistent style base, 7–11 mm diameter, valvate-dehiscent, glabrous; **seeds** 4, 5–7 mm long, brown, moderately to sparsely puberulent, with long hairs to 2 mm on the outer margins. **Fig. 2.**

***Additional specimens examined*: Queensland.** COOK DISTRICT: Palmerville Holding, Oct 1990, *Godwin C3649* (BRI); Belgravia, 3 km W of Mungana, May 1999, *Gray 7553* (BRI); Mungana N.P., The Archways, NW of Chillagoe, Feb 1996, *Forster PIF18598 & Ryan* (BRI); 4 miles [*c.* 6 km] N of Mungana, May 1970, *Webb & Tracey 10184* (BRI); Belgravia, 2.5 km E of Mungana, Feb 1999, *Gray 7445* (BRI); Royal Arch Tower, *c.* 5 km SW of Chillagoe, Mar 1987, *Clarkson 6829 & McDonald* (BRI).

***Distribution and habitat*:** *Ipomoea densivestita* is endemic to a small area in north-eastern Queensland (**Map 2**). Collections have been made from near Chillagoe and Palmerville. It grows in deciduous vine thickets on limestone outcrops.

***Phenology*:** Flowers have been recorded from January to May; fruit recorded in May and October.

***Affinities*:** *Ipomoea densevestita* is related to *I. abrupta,* which is extremely variable and contains a complex of taxa including *I. velutina* R.Br. and the Western Australian taxa, *I.* sp. (Carson Escarpment A.S.George 13732) and *I.* sp. (Cascade Creek R.L & M.D.Barrett RLB3738). In a narrow sense *I. abrupta* is a glabrous liana while *I. velutina* has pubescent foliage though the calyx is ± glabrous. The seeds of *I. abrupta sens. lat.* are covered in woolly hairs, unlike *I. densivestita* which has puberulent seeds with longer hairs on the outer margins. *Ipomoea abrupta sens. lat.* grows in sandstone areas, mainly in forests whereas *I. densivestita* appears restricted to vine thicket vegetation growing on limestone. More studies of specimens in the *I. abrupta* complex are required.

***Conservation status*:** *Ipomoea densivestita* occurs in a small geographical area near Chillagoe and Palmerville in north-eastern Queensland. It is rare in that area and requires conservation assessment.

***Etymology*:** The specific epithet is derived from the Latin *densus,* meaning dense and *vestitus*, meaning vestiture. This refers to the dense indumentum on stems and leaves and reflects the intent of the epithet, *lasiophylla* used by Domin.

Ipomoea dunlopii R.W.Johnson **species nova**; affinis *I. abruptae* R.Br., sed sepalis breviora, laevibus (non bullatis), praesertim fructiferis longitudinis 1/3 ostendens (non ± perfecte capsulam maturam includentibus) differens. Planta perennis, caules serpentes et volubiles. Folia simplicia, late ovata, interdum hastata. Inflorescentia cymosa, 1–3(–5)-flora. Sepala exteriora late ovata usque ad orbicularia, ± laevia. Corolla infundibuliformis, glabra. Semina lanata. **Typus:** Northern Territory. DARWIN & GULF: Mt Brockman Outlier, 15 km SE of Jabiru, 20 April 1989, *R.W.Johnson 4732* (holo: BRI; iso: DNA, PERTH, *distribuendi*).

Glabrous liana with trailing and twining stems; **stems** terete, woody at the base. **Leaves** simple, petiolate; **petiole** 25–75 mm long, 0.35–0.7 times as long as the blade; **blade** narrowly to broadly ovate or triangular, sometimes with rounded hastate lobes at the base, 50–150 mm long, 15–120 mm wide, with a length:width ratio of 1–4, apex acute, mucronate, base truncate to cordate with a broad sinus, midrib with a pair of slit-shaped glands at the base and 7–12 pairs of secondary veins and coarsely reticulate venation. **Inflorescence** axillary, compound cymose, 1–6(11)-flowered; **peduncle** stout, terete, 2–30 mm long; **bracteoles** opposite, herbaceous, abscissing prior to flowering; **pedicels** terete, dilated upwards, 12–35 mm long, with 5 small slit-shaped glands below the calyx. **Outer sepals** concave, broadly ovate to broadly oblong 5.5–8.5 mm long, 6–7 mm wide in flower, becoming ovate-orbicular in fruit and extending to 10 mm × 9.5 mm, apex

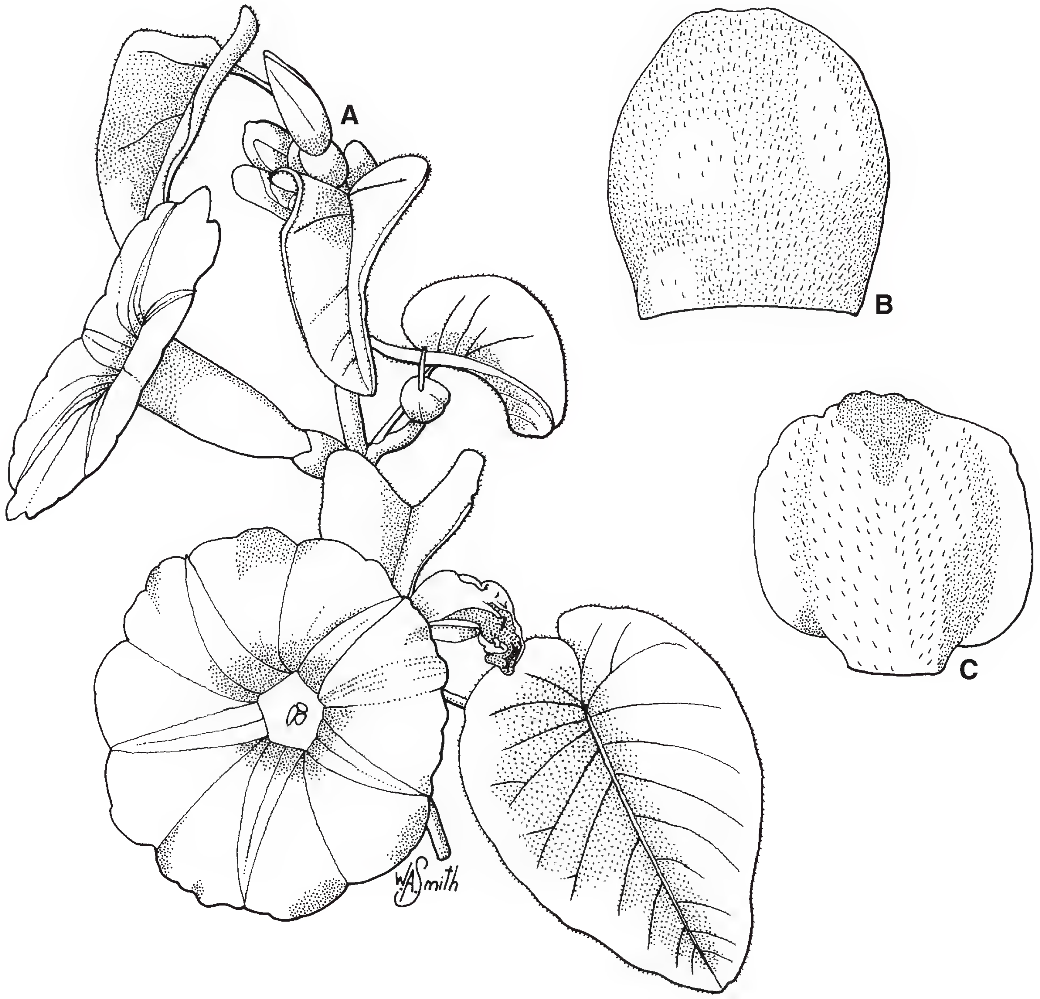

Fig. 2. ***Ipomoea densivestita***. A. flowering branch ×0.8. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. A–C from *Clarkson 6829 & McDonald* (BRI). Del. W.Smith.

obtuse to rounded, base obtuse to rounded, thickened with a narrow hyaline margin, surface smooth, rarely slightly wrinkled; **inner sepals** broadly oblong, broadly ovate or orbicular, 7.5–9 mm long, 8–9.5 mm wide, becoming broader in fruit and extending to 10 mm × 11.5 mm, apex rounded, slightly emarginate, base rounded to subcordate. **Corolla** funnel-shaped, 55–70 mm long, mauve to purple; **petals** 65–85 mm long, lobes rounded, emarginate, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for 10–11 mm; **filaments** free for 15–24 mm, with multicellular hairs from just below the point of attachment for 6–7 mm; **anthers** linear to oblong, sagittate, 6–7 mm long, *c.* 1 mm wide with basal lobes 0.75–1 mm long; **pollen** globular, spinulose. **Ovary** 2-locular, glabrous; **style** 32–40 mm long; **stigma** biglobular. **Capsule** globular to depressed-globular, 10–13 mm long, 10–14 mm diameter, valvate-dehiscent, glabrous; **seeds** 4, 6–7 mm long, black, covered in very long dense, sinuous, white to pale brown hairs to 4 mm long, longest on back and margins. **Fig. 3.**

***Additional specimens examined*: Northern Territory.** 10 km SW of Oenpelli Aboriginal Settlement, May 1988, *Weber 9860* (AD, BRI, DNA); Cannon Hill Airstrip, Jan 1973, *Martensz AE612* (BRI, DNA); Kakadu N.P., Ngarradj, Jan 1992, *Russell-Smith 8562 & Lucas* (BRI); East Alligator River, Feb 1973, *Dunlop 3204* (BRI); 2 km SW Ngarradj Creek crossing, Jabiru – Oenpelli Road, Jan 1984, *Russell-Smith 1175* (DNA); SE of Mt Howship, Feb 1984, *Dunlop 6638* (DNA); Arnhem Land, 19 km E of Jabiru, Apr 1989, *Johnson 4520, 4527, 4600* (BRI); Upper East Alligator River, Arnhem Land, Feb 1991, *Brock 768 & Russell-Smith* (BRI, DNA); Kakadu N.P., Koongarra, Feb 1992, *Russell-Smith 8709* (DNA); Mt Brockman, *s.dat.*, *Smyth s.n.* (BRI); Mt Brockman Outlier, 15 km SE of Jabiru, Apr 1989, *Johnson 4634, 4786, 4823* (BRI); Kakadu N.P., South Magela Gorge, 8 km SW of Mt Brockman, Jabiru Town, Jan 1991, *Brennan 901* (DNA); Kakadu N.P., Baroalba Creek, upstream from springs, Jabiru Town, Dec 1990, *Brennan 781* (DNA); near Buffalo Springs, Mt Brockman, 4 km NNE of Koongarra, May 1980, *Craven 5764* (BRI, CANB, DNA); Little Nourlangie Rock, Mar 1978, *Dunlop 4703* (BRI, DNA); Deaf Adder Gorge, Feb 1977, *Fox 2507* (DNA); 6 km S of Mt Gilruth, Arnhem Land, Mar 1984, *Jones 1537* (BRI, DNA); top of Jim Jim Falls, Jan 1981, *Dunlop 5694* (BRI, DNA); Kakadu, graveside gorge, Dec 1986, *Brock 192* (DNA); 1 km upstream from Twin Falls, Mar 1988, *Fensham 777* (DNA).

***Distribution and habitat*:** *Ipomoea dunlopii* is found in a small area of Arnhem Land S of Oenpelli (**Map 2**). It occurs on the top, and in flats and gullies, of broken sandstone plateaux. It grows in vine thickets, sandstone heaths and eucalypt forests and woodlands on sandy soils.

***Phenology*:** Flowers have been recorded from January to April; fruit have been recorded from March to May.

***Affinities*:** *Ipomoea dunlopii* is related to *I. abrupta* which occurs mainly in coastal and subcoastal areas. It differs from *I. abrupta* in having sepals, at fruiting, which are smooth, shorter and enclose only the lower two-thirds of the capsule. In *I. abrupta* the sepals become bullate and enclose the mature capsule. Juvenile foliage in *I. dunlopii* can become narrow and distinctly hastate which I have not noticed in *I. abrupta*.

***Conservation status*:** It is found in a relatively restricted but protected area in Arnhem Land and is not known to be threatened.

***Etymology*:** This species is named in honour of a friend and colleague, Clyde Dunlop, who made possible my trip to Arnhem Land, where the type of this species was collected.

Ipomoea funicularis R.W.Johnson **species nova**; affinis *I. gracili* R.Br., sed caulibus funicularibus (non herbaceis), foliis semper hastato-sagittatis (raro hastatis), sepalis exterioribus sub anthesi longioribus, 10–17 mm longis (non 8–13 mm longis) et petalis longioribus, 60–75 mm longis (non 45–60 mm longis) differens. Planta perennis, caules repentes et volubiles, lignescentes. Folia simplicia, lamina hastata usque ad sagittata. Inflorescentia cymosa, 1–2-flora. Sepala exteriora ovata, acuta, nervis 3–5, longitudinalibus, elevatis, tuberculatis et rugosis in dimidio inferiora. Corolla infundibuliformis, glabra. Semina puberula, caespite longiorum pilorum ad hilum. **Typus:** Queensland. Cook District: Undara National Park, NE of Barkers Knob, 14 February 2005, *K.R.McDonald KRM3610 & C.O'Keefe* (holo: BRI, iso: DNA, PERTH, *distribuendi*).

Ipomoea gracilis var. *sagittata* F.Muell., *Fragm.* 6: 99 (1868). **Type:** Queensland. Rockingham Bay, *s.dat.*, *J.Dallachy s.n.* (lecto: MEL 2260143, here designated; isolecto: MEL 2260141).

Perennial with a tuberous root and trailing stems, twining at the tips; **stems** terete, tough and fibrous, glabrous, sometimes sparsely hairy. **Leaves** simple, petiolate; **petiole** 14–50 mm long, 0.25–0.65 times as long as the blade, ± glabrous, occasionally with a few, weak, sinuate hairs and low tubercles; **blade** hastate to hastate-sagittate, 55–100 mm long, 30–60 mm wide, with a narrow-linear terminal lobe, 40–90 mm long, 2–18 mm wide, and a pair of spreading linear to linear-triangular basal lobes, apex narrowly obtuse to rounded, sometimes retuse, mucronate, base subcordate to cordate with a wide sinus up to 22% of blade, glabrous, midrib with a pair of slit-shaped basal glands and 6–8 pairs of secondary veins. **Inflorescence** axillary, cymose, 1–2-flowered, rarely compound; **peduncle** terete, stout, 2–20 mm long, ±glabrous, occasionally with vestiture as for petiole; **bracteoles** opposite, herbaceous,

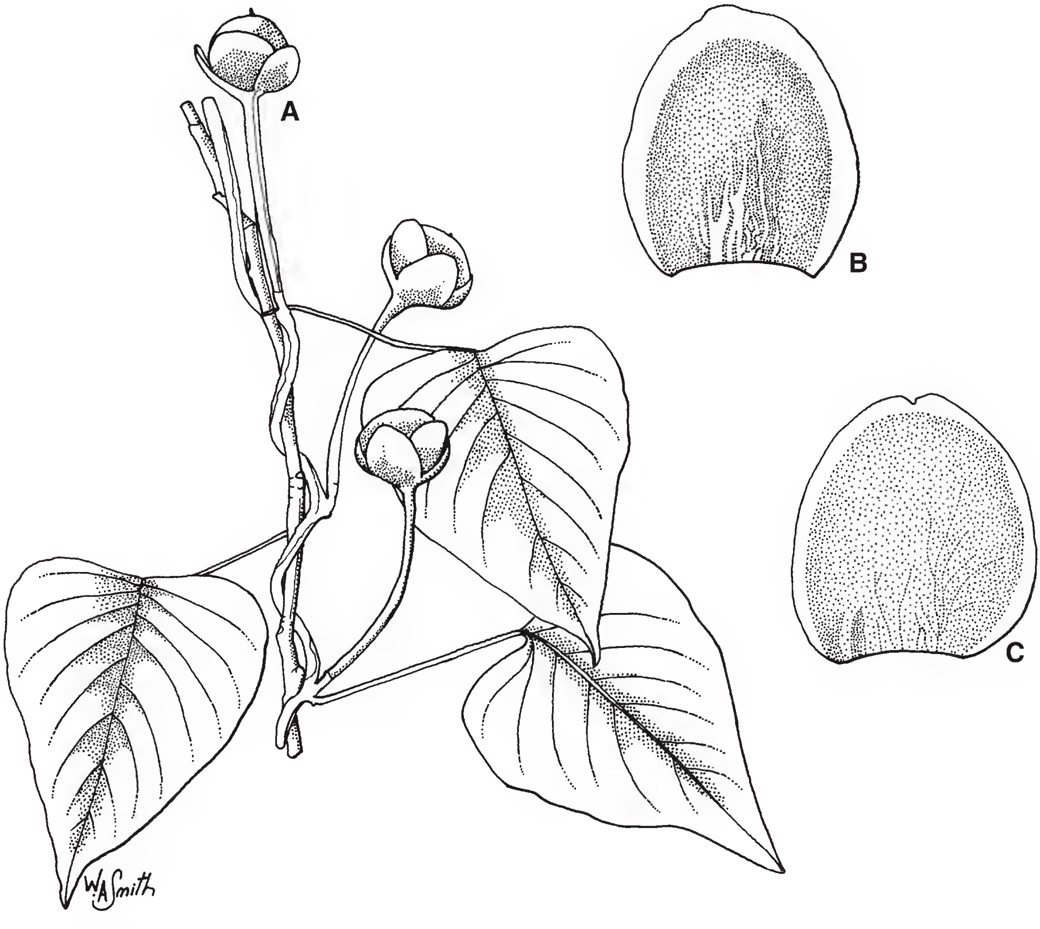

Fig. 3. ***Ipomoea dunlopii***. A. fruiting branch ×0.8. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. A from *Johnson 4786* (BRI); B–C from *Johnson 4732* (BRI). Del. W.Smith

narrowly triangular, 3–8 mm long, apex acute, persistent; **pedicels** terete, dilated upwards, 7–16 mm long, bearing 5 slit-shaped glands below the calyx. **Outer sepals** ovate, narrowly ovate or ovate-elliptic to ovate-lanceolate, 10–15 mm long, 3.5–5.5 mm wide in flower, extending to 8 mm wide in fruit, apex acute, often inrolled, base rounded, surface with 3–5 prominent longitudinal veins, with some tubercles and transverse ridges; **inner sepals** narrowly ovate to ovate-elliptic, 11–16 mm long, 5–6 mm wide, extending to 9 mm wide in fruit, apex inrolled, acute, base truncate to sub-cordate, with 3 slightly raised longitudinal veins and a narrow hyaline margin, broader at the base. **Corolla** funnel-shaped, 50–60 mm long; **petals** 60–75 mm long, pink, often with a darker centre, lobes rounded, apiculate, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for 8–10 mm; **filaments** free for 10–22 mm, with dense, sinuate, multicellular hairs from just below the point of attachment upwards for ± 6 mm; **anthers** linear to narrowly ovate-lanceolate, sagittate, 3.5–4 mm long, with basal lobes 0.5–0.75 mm long; **pollen** globular, spinulose. **Ovary** 2-locular, ovoid with a prominent disk; **style** 27–40 mm long; **stigma** biglobular. **Capsule** globular to depressed globular, 8–10 mm long, valvate-dehiscent, glabrous; **seeds** 4, 4–5 mm long, dark brown, puberulent with a tuft of long silvery brown hairs to *c.* 1.5 mm around the hilum. **Fig. 4.**

***Additional selected specimens* (*from 29 examined*): Queensland.** Burke District: 38.6 km SW of Hells Gate Roadhouse on Bowthorn Station, Apr 2006, *Thompson & Edginton WES331* (BRI). Cook District: *c.* 28 km SSE of Laura, just S of Hell's Gate, Jun 2006, *Wannan & Caldwell 4457* (BRI); Mareeba, 0.5 miles [*c.* 1 km] S on Atherton Road, Jan 1962, *Webb 5528* (BRI); 5 km by road from junction with Burke Development Road towards Ootann, Jan 2005, *McDonald KRM3516* (BRI); Almaden – Mt Surprise Road, near Almaden, Jun 2008, *McDonald KRM5327 & Sellars* (BRI); 35 km from Almaden on road to Mt Surprise, Jan 1992, *Forster PIF9620* (BRI); Blue Hills, Mt Surprise, 49 km from Mt Surprise Township, Mar 1988, *Champion 363* (BRI); 3 km E of Mt Surprise, Feb 2004, *McDonald KRM1791* (BRI); Undara N.P., NE of Barkers Knob, Dec 2006, *McDonald KRM4681* (BRI); 62.2 km by road W of Mt Surprise on E approach to Newcastle Range, Mar 2006, *McDonald KRM4928* (BRI); Newcastle Range, 64 km from Mt Surprise on Georgetown Road, Mar 1988, *Forster PIF3811* (BRI); Black Rock near Lynd on Hughenden Road, Feb 1988, *Horsup 6* (BRI); 19.7 km by road towards Forsayth from Einasleigh, Mar 2005, *McDonald KRM3787* (BRI); Newcastle Range, Agate Creek catchment, Simpson's Gully, Apr 2006, *McDonald KRM5245* (BRI). North Kennedy District: Herberton, Jan 1912, *Kenny s.n.* (BRI); Castle Hill, Townsville, Mar 1992, *Bean 4099* (BRI); Mt Norman, 55 km S of Townsville, Jan 1999, *Cumming 18473* (BRI); Princess Dam Road, Lumholtz N.P., Jan 2003, *McDonald KRM1226* (BRI). South Kennedy District: Broken River Range, Apr 1978, *Byrnes & Clarkson 3672* (BRI). Mitchell District: *c.* 32 km SE of Hughenden, Apr 1998, *Thompson & Turpin HUG582* (BRI).

***Distribution and habitat*:** *Ipomoea funicularis* occurs in north-eastern Queensland from south of Laura, south to the Broken River Range, west of Mackay and inland to the Gulf of Carpentaria, near Burketown, SSE of Georgetown and to the south-east of Hughenden (**Map 1**). It grows in eucalypt woodland communities mainly with ironbarks and bloodwoods on sandy, sometimes gravelly soils, on rocky slopes and low hills, derived mainly from granite.

***Phenology*:** Flowers have been recorded from December to June; fruits have been recorded from December to April.

***Affinities*:** *Ipomoea funicularis* is closely related to *I. gracilis*. It has a much more robust habit with wiry, semi-woody stems much tougher than the herbaceous stems of *I. gracilis*. Its leaves are always hastate-sagittate at the base, though on rare occasions *I. gracilis* can have hastate lobes. The calyx and corolla of *I. funicularis* are larger than that of *I. gracilis*. Its foliage can also resemble that of *I. brassii* C.T.White but the species are clearly distinguished by seed vestiture. *Ipomoea funicularis* has puberulent seeds with a tuft of longer hairs at the hilum whereas the seeds of *I. brassii* are villose. The peduncle is also much longer than the pedicel in *I. brassii* and the corolla lacks the darker centre which is found in *I. funicularis*.

***Conservation status*:** *Ipomoea funicularis* is a widespread species and not known to be threatened.

***Etymology*:** The specific epithet is derived from the Latin *funicularis,* meaning rope-like. This refers to tough, fibrous texture of the stems, which distinguishes this species from *I. gracilis* which has herbaceous stems.

Ipomoea kalumburu R.W.Johnson **species nova**; affinis *I. muelleri* Benth., sed seminibus puberulis, caespite pilorum longiorum ad hilum (non villosis) et bracteis, corolla et sepalis longioribus differens. Planta perennis, caules serpentes. Folia simplicia, lamina late ovata usque ad triangulata, integera. Inflorescentia cymosa, 1–(2–3)-flora. Sepala exteriora ovata, acuta, ± laevia. Corolla infundibuliformis, glabra. Semina puberula, caespite pilorum longiorum ad hilum. **Typus:** Western Australia. Cattle paddock, eastern bank of King Edward River, 1.06 km from Kalumburu Mission, 31 March 2001, *A.A.Mitchell 6685* (holo: PERTH; iso: BRI).

Ipomoea sp. Kalumburu (A.A.Mitchell 3869B); Short *et al.* (2011); Western Australian Herbarium (2011).

Glabrous perennial with trailing, scrambling and climbing stems; **stems** terete, herbaceous, sometimes rooting at the basal nodes. **Leaves** simple, petiolate; **petiole** 15–110 mm long, 0.45–0.8(–1.3) times as long as the blade; **blade** broadly ovate-triangular to deltoid, entire, 25–55(–100) mm long, 25–45(–70) mm wide with a length:width ratio of 1.1–1.6, apex obtuse to narrowly rounded, emarginate, mucronate, base truncate to shallowly cordate with wide sinus up to 17% of blade, midrib with a pair of slit-shaped glands at the base

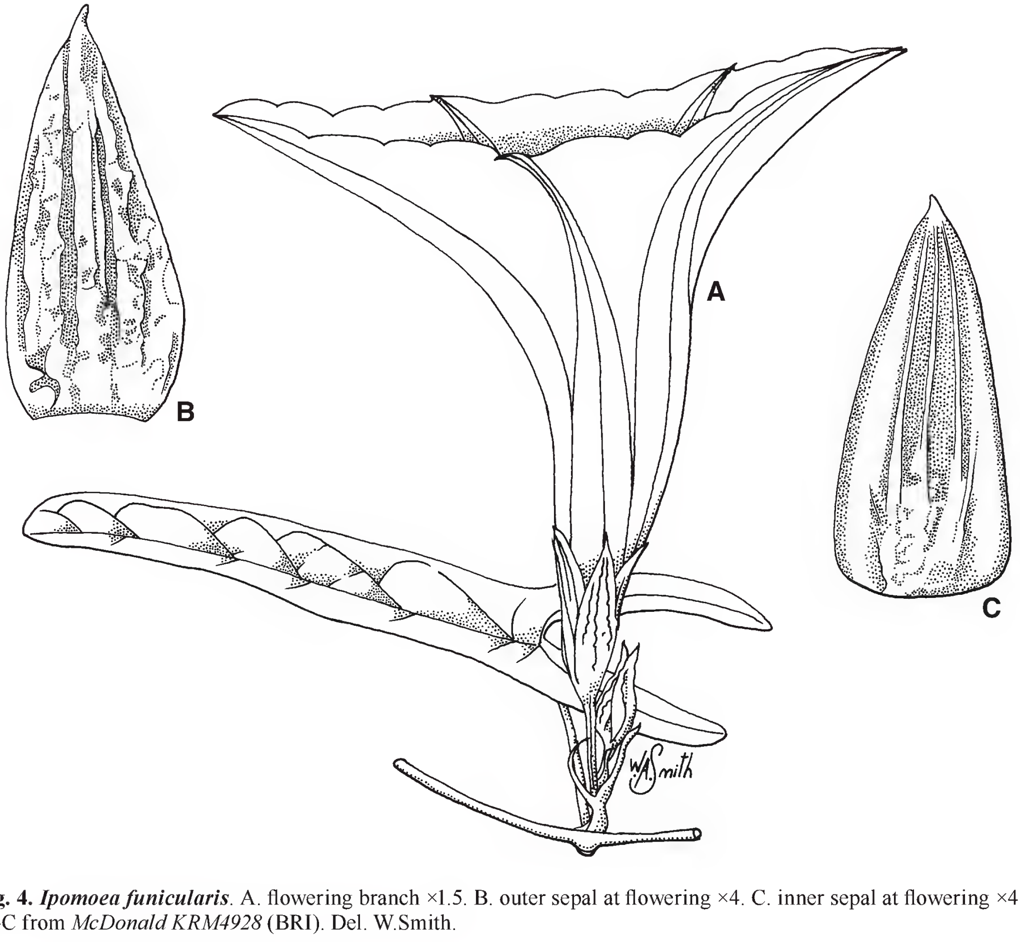

Fig. 4. ***Ipomoea funicularis***. A. flowering branch ×1.5. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. A–C from *McDonald KRM4928* (BRI). Del. W.Smith.

and 3–6 pair of secondary veins often with a purplish or reddish tinge. **Inflorescence** axillary, cymose, 1–(2–3)-flowered; **peduncle** terete, slender, 2–120 mm long; **bracteoles** opposite to sub-opposite, herbaceous, narrowly triangular-ovate, 3–7 mm long, apex acute, persistent; **pedicels** terete, dilated upwards, 6–16 mm long, bearing 5 linear slit-shaped glands below the calyx. **Outer sepals** ovate, narrowly ovate or ovate-oblong to narrowly ovate-lanceolate, 8–16 mm long, 4–5.5 mm wide in flower, becoming broader in fruit, apex acute, often inrolled, apiculate, base rounded, surface with 3 longitudinal veins, often slightly raised, smooth or with an occasional tubercle; **inner sepals** narrowly ovate-triangular to narrowly deltoid, 10–14 mm long, 5.5–7 mm wide, apex acute, rarely obtuse, often inrolled, base subcordate with a narrow hyaline margin, broader at the base. **Corolla** funnel-shaped, 40–55 mm long, 40–50 mm diameter, mauve to purple; **petals** 45–65 mm long, lobes rounded, apiculate, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for 6–8 mm; **filaments** free for 9–16 mm, with dense, sinuate, multicellular hairs, from just below the point of attachment upwards for 5–7 mm; **anthers** linear to narrowly ovate-lanceolate, sagittate, 2.3–2.8 mm long, with basal lobes 0.5–0.6 mm long; **pollen** globular, spinulose. **Ovary** 2-locular, hemispherical with a prominent disk; **style** 22–25 mm long; **stigma** biglobular. **Capsule** ovoid to globular, 10–12 mm long, valvate-dehiscent, glabrous; **seeds** 4, 5–6 mm long, dark brown, puberulent with a tuft of long whitish hairs around the hilum. **Fig. 5.**

***Additional specimens examined*: Western Australia.** S of Loure Creek, Kalumburu Mission, Oct 2002, *Mitchell 7356* (PERTH); cattle paddock, Kalumburu Mission, N Kimberley, May 1996, *Brockway CB80* (BRI, PERTH); *c.* 0.5 km S of Kalumburu Mission, S bank King Edward River, Mar 1995, *Mitchell 3869* (BRI, PERTH); Kalumburu Mission cattle paddock, levee King Edward River, Jun 1996, *Mitchell 4428* (BRI, PERTH); south bank of the King Edward River, about 1 km S of Kalumburu Mission, cattle paddock, Feb 1966, *Mitchell 4256* (PERTH).

***Distribution and habitat*:** *Ipomoea kalumburu* occurs at Kalumburu, north Kimberley, Western Australia (**Map 1**). It is found mainly in grasslands with *Sorghum, Themeda* and *Heteropogon* on sandy alluvial soils.

***Phenology*:** Flowers have been recorded between January and October; fruit between January and June.

***Affinities*:** *Ipomoea kalumburu* resembles *I. muelleri*, but can be distinguished by its longer calyx and corolla. Its seeds are puberulous, with a tuft of longer hairs around the hilum, whereas in *I. muelleri* the seeds are villous. It also resembles *Ipomoea limosa* R.W.Johnson, but it has a simple cymose inflorescence with one, rarely 2 or 3 flowers and ± smooth calyx lobes, unlike *I. limosa* which has simple and compound cymes, often many flowered, and sepals with distinct longitudinal veins which are tuberculate and rugose, particularly in the lower half.

***Conservation status*:** It is regarded as a priority 1 taxon in Western Australia (Western Australian Herbarium 2011).

***Etymology*:** The specific epithet, *kalumburu,* refers to the name of the aboriginal settlement in northern Western Australia where it is found. Kalumburu is an aboriginal word meaning “Path by the river or river crossing”.

Ipomoea limosa R.W.Johnson **species nova**; affinis *I. argillicola* R.W.Johnson, sed laminis ovato-lanceolatis, sagittatis vel hastatis, < 1.6-plo longioribus quam latioribus (non late ovatis, cordatis, > 2-plo longioribus quam latioribus) differens. Planta perennis, caules serpentes. Folia simplicia, lamina ovato-lanceolata, sagittata vel hastata. Inflorescentia cymosa. 1–3(–5)-flora. Sepala exteriora ovata, acuta, nervis 3–5, elevatis, longitudinalibus, tuberculatis et rugosis in dimidio inferiore. Corolla infundibuliformis, glabra. Semina puberula, caespite pilorum longiorum ad hilum. **Typus:** Western Australia. *c.* 1 km E of Dumas Lookout, Ord Irrigation Project, 23 April 1983, *K.L.Wilson 4810* (holo: BRI; iso: NSW *n.v.*, PERTH).

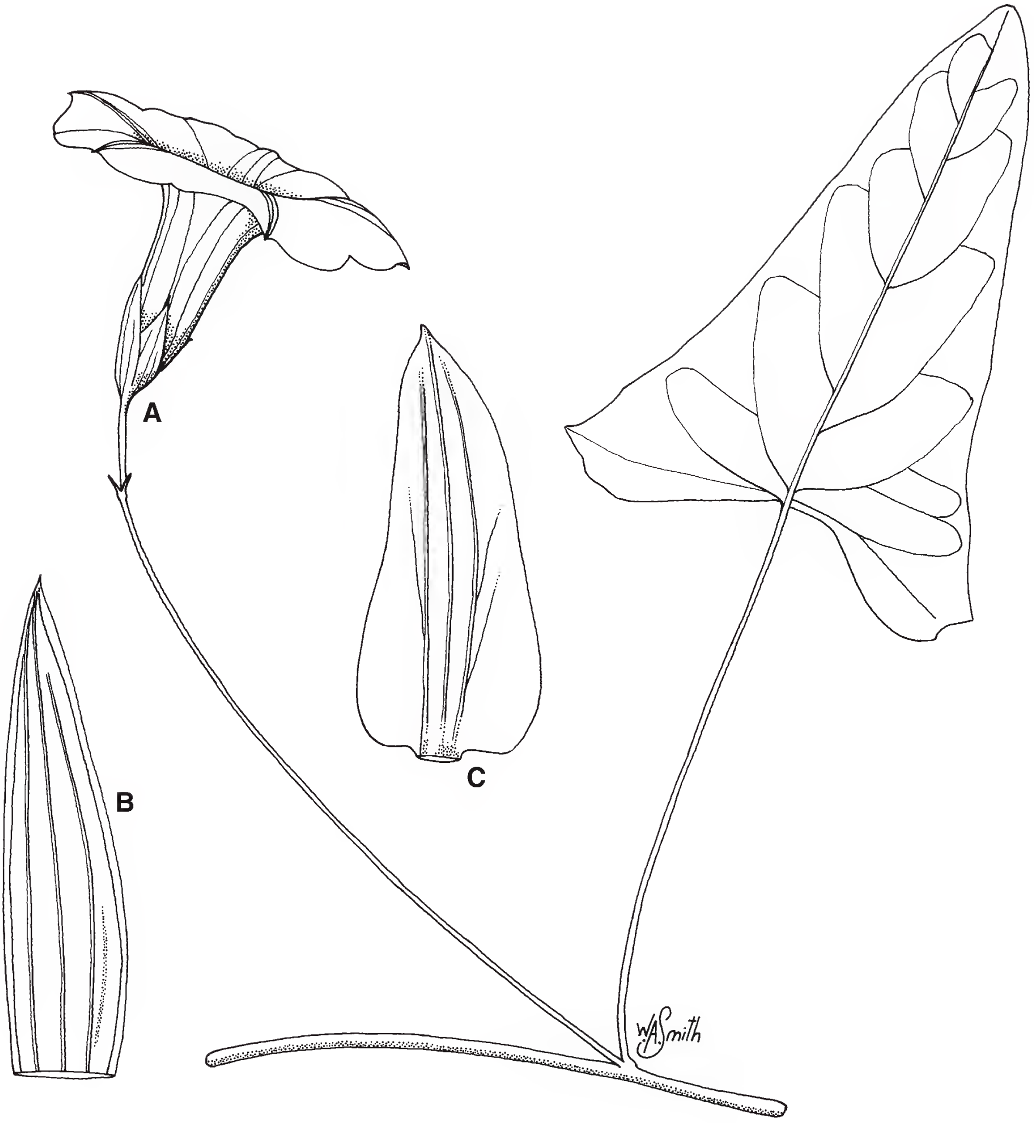

Fig. 5. ***Ipomoea kalumburu***. A. flowering branch ×0.8. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. All from *Mitchell 3869* (PERTH). Del. W.Smith.

Ipomoea sp. (Kununurra T.E.Aplin 6307); Johnson (2007, 2010).

Perennial with trailing, occasionally climbing stems; **stems** herbaceous, stout, terete, becoming hollow, glabrous to very sparsely hairy, young stem tips resinous. **Leaves** simple, petiolate; **petiole** 30–140 mm long, 0.4–1.4 times as long as the blade, glabrous, sometimes with scattered low tubercles; **blade** ovate to ovate-lanceolate or oblong-lanceolate, sagittate, 50–160 mm long, 25–65 mm wide, length:width ratio1.2–2.6, at times becoming hastate-sagittate with a narrow triangular terminal lobe 30–80 mm long, 15–45 mm wide extending to 105 mm wide at the bluntly hastate base with length:width ratio decreasing to 1, apex narrowly obtuse to rounded, often emarginate, mucronate, with a broadly rounded sinus, 5–25% of the length of the blade, glabrous, midrib with prominent slit-shaped glands at the base and 6–8 pairs of secondary veins. **Inflorescence** axillary, cymose, 1–5-flowered; **peduncle** terete, 4–110(–180) mm long, glabrous, sometimes sparsely tuberculate; **bracteoles** opposite to sub-opposite, herbaceous, narrowly ovate-lanceolate, 3–10(–18) mm long, acute, mucronulate, attenuate to rounded at base occasionally becoming foliate, clavate and rounded at the apex, glabrous, persistent at flowering and early fruiting; **pedicels** terete, dilated upwards, 5–25 mm long, glabrous, with 5 small slit-shaped glands under the calyx. **Outer sepals** ovate-lanceolate, oblong-lanceolate or narrowly oblong, 13–20 mm long, 4.5–6.5 mm wide in flower, extending to 8.5 mm wide in fruit, apex acute, inrolled, mucronulate, base attenuate to rounded, thick with a thin hyaline margin, bearing 3–5 raised longitudinal veins tuberculate in the lower two-thirds, rugose towards the base, glabrous; **inner sepals** ovate-lanceolate to deltoid-lanceolate, 16–19 mm long, 7–8 mm wide, apex acute, inrolled, mucronulate, base truncate to subcordate, with 3–5 slightly raised longitudinal veins and a hyaline basal margin, glabrous. **Corolla** funnel-shaped, 50–60 mm long, pale pink to mauve; **petals** 55–75 mm long, lobes rounded, apiculate, midpetaline band glabrous. **Stamens** 5 included, attached to the base of the corolla for 10–15 mm; **filaments** free for 10–16 mm, with multicellular hairs from just below the point of attachment upwards for 6–8 mm; **anthers** oblong-lanceolate, sagittate, 3.2–3.6 mm long with basal lobes 0.6–0.8 mm long; **pollen** globular, spinulose. **Ovary** ovoid with a prominent disk, 2-locular, glabrous; **style** 28–35 mm long; **stigma** biglobular. **Capsule** globular to depressed globular, 9–12 mm long, 9–12 mm diameter, valvate-dehiscent, glabrous; **seeds** 4, 5.5–6.5 mm long, brown to dark brown, puberulent, with a tuft of long hairs to 2 mm around the hilum. **Fig. 6.**

***Additional specimens examined*:** **Western Australia.** Kimberley Research Station, Ord River, Apr 1958, *Burbidge 5774* (PERTH); 3 km N of Kununurra, Sep 1974, *Must 1270* (BRI, PERTH); Block 48, along track on edge of block near channel, Kununurra, Mar 1978, *Aplin 6307* (BRI, PERTH); Kununurra, Mar 1967, *Hardy s.n.* (PERTH3639940); Kununurra, May 1967, *Scrymgeour 1696* (PERTH); Charnley River Crossing, 57 km N of Beverley Springs Station Homestead, Dec 1994, *Barrett RLB998* (PERTH); 2 km SW of Beverley Springs Station Homestead, Feb 1995, *Barrett RLB983* (PERTH); Ord River, 1948, *Langfield 16* (PERTH). **Northern Territory.** Bradshaw Field Training Area, headwaters of Little Fitzmaurice River, 65 km from Timber Creek, Apr 2007, *Cowie 11520 & Stuckey* (DNA); Limmen N.P., *c.* 25 km N of Limmen Bight River, Apr 2008, *Lewis 753* (DNA); 40.5 miles [65 km] S of Willeroo Homestead, May 1960, *Chippendale 6895* (DNA); 25 miles [40 km] N of Daly Waters, Mar 1955, *Winkworth 1112* (DNA); Tanumbirini Station, Carpentaria Highway, Feb 1988, *Thomson 2247* (DNA); 4 miles [6.5 km] S of Dunmarra, Mar 1955, *Chippendale 1060* (BRI, DNA); 8.5 km S of Dunmarra, May 1994, *Latz 13708* (BRI, DNA); Cattle Creek Station, 5.6 km N of Mt Gordon, May 2004, *Cowie 10339 & Coleman* (DNA). **Queensland.** Burke District: 13.5 km SW of Normanton, Apr 1996, *Milson JM1049* (BRI); Normanton – Burketown Road, Jan 2001, *McDonald KRM692* (BRI); 6.1 km by road along Burke Development Road from junction with Gulf Development Road, Jan 2005, *McDonald KRM3444* (BRI); 6.4 km along Burke Development Road from junction with Gulf Development Road, Apr 2007, *McDonald KRM6532* (BRI); 6.1 km from Burke and Gulf Development Roads junction, Apr 2009, *McDonald KRM8411* (BRI-spirit only).

***Distribution and habitat*:** *Ipomoea limosa* occurs from east of Derby to Kununurra in the Kimberley region of Western Australia, eastwards to south of the Gulf of Carpentaria, near Normanton in Queensland (**Map 2**). It grows in grasslands with *Sorghum*, *Themeda* and *Dichanthium*; open woodlands with emergent eucalypts such as coolibah and box, occasionally with *Melaleuca,* on alluvial clay soil plains, commonly in moister areas.

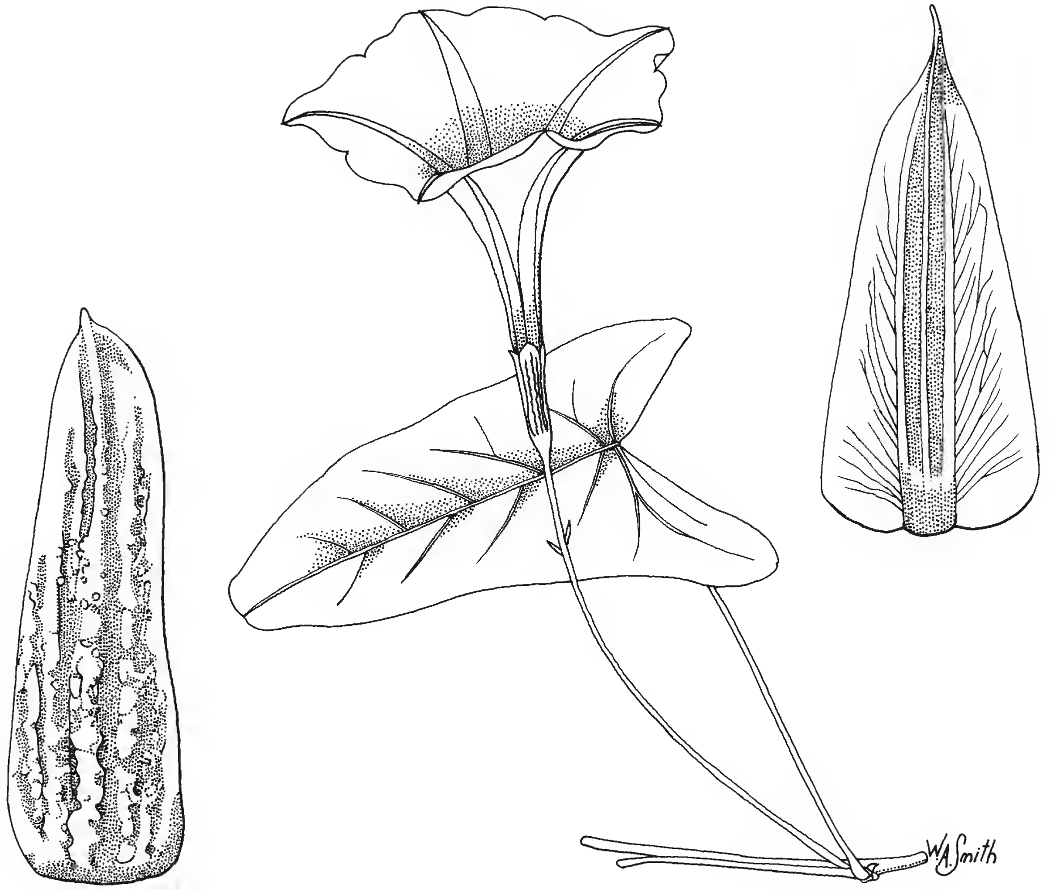

Fig. 6. ***Ipomoea limosa***. A. flowering branch ×0.8. B. outer sepal at flowering ×4. C. inner sepal at flowering ×4. A from *McDonald KRM3444* (BRI) and photos of *McDonald KRM6532*, *8411* (BRI); B–C from *McDonald KRM8411* (BRI). Del. W.Smith.

***Phenology*:** Flowers have been recorded from January to May and also in September; fruits have been recorded in April and May.

***Affinities*:** *Ipomoea limosa* resembles *I. argillicola* but can be distinguished by its leaf shape which is ovate-lanceolate, >2 times as long as broad and sagittate or hastate at the base. In *I. argillicola* the leaves are broadly ovate, <1.6 times as long as wide and cordate to truncate at the base. *I. limosa* also has much shorter peduncles and pedicels. *I. limosa* is found in moist depressions on clay soil plains. *I. argillicola* occurs on cracking clay soils in grasslands and grassy eucalypt woodlands.

***Conservation status*:** *Ipomoea limosa* is widely spread throughout northern Australia and is not known to be threatened.

***Etymology*:** The specific epithet is derived from the Latin *limosa,* meaning muddy. This refers to the habitat of this species, which commonly grows in muddy places.

Ipomoea tolmerana R.W.Johnson **species nova**; affinis *I. gramineae* R.Br., sed laminis hastatis (non integris), sepalis externis rugosis (non laevibus) et corollis infundibuliformibus (non hypocrateriformibus) differens. Planta perennis, caules serpentes et volubiles. Folia simplicia, lamina peranguste linearis, vix usque ad manifeste hastata. Inflorescentia cymosa, 1–(2–3)-flora. Sepala exteriora ovata, acuta, nervis 3–5, longitudinalibus, elevatis, tuberculatis et rugosis in dimidio inferiore. Corolla infundibuliformis, glabra. Semina puberula, caespite pilorum longiorum ad hilum. **Typus:** Northern Territory. Litchfield National Park, Walker Creek Ranger Station, 14 March 1995, *I.D.Cowie 5366 & S.Taylor* (holo: BRI [AQ597032]; iso: DNA).

Perennial with a tuberous root and trailing and twining stems, rooting at the lower nodes; **stems** terete, herbaceous, glabrous or with a few hairs at the leaf nodes, occasionally very sparsely to moderately hairy with tubercle-based hairs to 0.5 mm. **Leaves** simple, petiolate; **petiole** 7–45 mm long, 0.1–0.3 times as long as the blade, vestiture as for the stem; **blade** narrowly linear to very narrowly ovate, 60–150 mm long, with a slightly to distinctly hastate base, terminal lobe 1–6 mm wide, basal lobes 4–50 mm long, 1–2 mm wide, often recurved, apex acute to narrowly obtuse, apiculate, base truncate to subcordate, glabrous, occasionally sparsely hairy mainly below, with hairs confined to major veins, erect to retrorse, tubercle-based, midrib with a pair of slit-like glands at the base. **Inflorescence** axillary, cymose, 1, rarely 2–3-flowered; **peduncle** terete, 2–30 mm long, vestiture as for the stem; **bracteoles** opposite to subopposite, herbaceous, narrowly triangular, 2–6 mm long, acute, glabrous to sparsely hairy, persistent; **pedicels** terete, slightly dilated upwards, 3–12 mm long in flower, extending to 23 mm in fruit, glabrous to moderately hairy**,** with glands below the calyx. **Outer sepals** narrowly lanceolate to narrowly ovate-elliptic, 8–16 mm long, 3.5–5.5 mm wide in flower, becoming wider in fruit, apex acute, apiculate, attenuate to rounded at base, with 3–5 prominent longitudinal tuberculate nerves, reticulate in lower part, glabrous; **inner sepals** ovate, ovate-lanceolate or oblong-lanceolate, 10–16 mm long, 4.5–6 mm wide, apex acute, with a rolled apiculate tip, base truncate with a broad hyaline margin, glabrous. **Corolla** funnel-shaped with a slender tube, 35–60 mm long, 30–50 mm diameter, white, lilac to mauve; **petals** 40–70 mm long, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for 8–9 mm; **filaments** free for 13–17 mm, with multicellular hairs from just below the point of attachment for 7–11 mm; **anthers** oblong, sagittate, 2.8–3.5 mm long with basal lobes 0.5–0.6 mm; **pollen** globular, spinulose. **Ovary** 2-locular, glabrous; **style** 26–28 mm long; **stigma** biglobular. **Capsule** globular, *c.* 10 mm long, 8–10 mm diameter, valvate-dehiscent, glabrous; **seeds** 4, 4.5–5.5 mm long, dark brown, sparsely to moderately densely puberulent, with a tuft of long whitish hairs to 2 mm around the hilum.

***Affinities*:** *Ipomoea tolmerana* resembles *I. graminea* in the vegetative state, but its leaves are always barely to distinctly hastate. Its relationships; however, lie more closely with the Australian representatives of the *I. gracilis* group (Austin *et al.* 1993) with which it shares a funnel-shaped corolla and puberulent seeds with a tuft of longer hairs around the hilum. From all of these related species it can be distinguished by its long narrow-linear, barely to distinctly hastate leaves.

Key to the subspecies of *I. tolmerana*

1 Corolla white, petals 50–70 mm long; outer sepals 9–16 × 5–5.5 mm and inner sepals 15–17 × 5–6 mm, at flowering. subsp. ***tolmerana***

1. Corolla lilac to mauve, petals 40–50 mm long; outer sepals 8–12 × 5–5.5 mm and inner sepals 11–13 × 6.5–7.5 mm, at flowering. . . . . subsp. ***occidentalis***

***Etymology*:** Named after Mt Tolmer where the initial collections were made. Since then, the taxon has been commonly referred to as "Ipomoea Tolmer" and "I. tolmeri". The mountain was named in honour of Alexander Tolmer (1815–1890), Commissioner of Police in South Australia.

Ipomoea tolmerana R.W.Johnson subsp. **tolmerana**

Ipomoea sp. Tolmer (C.R.Dunlop 6787); Short *et al.* (2011).

Leaf blades 60–150 mm long, basal lobes to 50 mm long; inflorescence cymose with 1 or 2 flowers, rarely 3-flowered; peduncles 2–30 mm long; pedicels 3–12 mm long, glabrous to moderately hairy; outer sepals 9–16 mm long, 5–5.5 mm wide and inner sepals 15–17 mm long, 5–6 mm wide, at flowering; corolla white, petals 50–70 mm long; seeds 5–5.5 mm long.

***Additional specimens examined*:** **Northern Territory.** Narbarlek, Arnhem Land, Mar 1989, *Hinz 447* (BRI, DNA); Western Arnhem Land, *c.* 91 km ESE of Jabiru, Mar 2000, *Cowie 8678* (DNA); Walker Creek Ranger Station, Mar 1995, *Cowie 5341 & Taylor* (DNA); Litchfield N.P., road from Batchelor, Nov 1992, *Leach 3356* (DNA); Tabletop Range, near Mt Tolmer, May 1985, *Dunlop 6787* (DNA); Litchfield N.P., near Lost City, Apr 1999, *Cowie 8293 & Brennan* (BRI, DNA); Round Jungle, Kakadu, Feb 1989, *Russell-Smith & Lucas 8005* (DNA); Litchfield N.P. south, track to Tableland Creek, Feb 1996, *Cowie 6193 & Booth* (BRI, DNA); Marrawal Plateau, near Bloomfield Springs, Feb 1996, *Brennan 3208* (DNA); Umbawarra Gorge, Feb 1978, *Gano s.n.* (DNA); Nitmiluk N.P., Site 566, Marrawal Plateau, Apr 2001, *Brennan 5630* (DNA); Nitmiluk N.P., Apr 2001, *Michell & Boyce 3360* (DNA); Nitmiluk N.P., Site 324, Mar 2001, *Risler & Waetke 1429* (DNA); *c.* 29 miles [*c.* 47 km] NE of Maranboy Police Station, Mar 1965, *Lazarides & Adams 18* (DNA).

***Distribution and habitat*:** *Ipomoea tolmerana* subsp. *tolmerana* occurs in northern Northern Territory, from Litchfield N.P., eastward to Narbalek and Maranboy (**Map 3**). It grows on sandstone plateaux, on sandy soils, often deep, in eucalypt open forest and woodland, often with *Eucalyptus tetrodonta* F.Muell. and *E. miniata* and a grassy understorey of *Sorghum*, *Themeda* and *Aristida* and some shrubs.

***Phenology*:** Flowers have been recorded from February to May, also in November; fruit have been recorded from March to April, also in November.

***Conservation status*:** It is a widespread species and not known to be at risk. It is not listed among the threatened species in the Northern Territory (Short *et al.* 2011).

Ipomoea tolmerana subsp. **occidentalis** R.W.Johnson **subspecies nova**; a subspecie typica corolla rosa usque ad malvina (in subspecie typica alba) et petalis brevioribus, 40–50 mm longis (non 50–70 mm longis), sepalis exterioribus sub anthesi brevioribus, 8–12 mm longis (non 9–16 mm longis) et sepalis interioribus sub anthesi brevioribus et latioribus, 11–13 × 6.5–7.5 mm (non 15–17 × 5–6 mm) differens. **Typus:** Western Australia. 1 km S of the roadhouse and 50 km N of Broome on the Beagle Bay Track, Dampier Peninsula, 27 March 2001, *A.A.Mitchell 6669* (holo: BRI; iso: DNA, PERTH).

Ipomoea sp. A; Wheeler & Marchant (1992).

Ipomoea sp. A Kimberley Flora (L.J. Penn 84); Western Australian Herbarium (2011).

Leaf blades 60–120 mm long, basal lobes to 25 mm long; inflorescence cymose, 1-, rarely 2-flowered; peduncles 3–15(–25) mm long; pedicels 8–14(–22) mm long, glabrous to sparsely hairy; outer sepals 8–12 mm long, 5–5.5 mm wide and inner sepals 11–13 mm long, 6.5–7.5 mm wide, at flowering; corolla lilac to mauve, petals 40–50 mm long; seeds 4.5–5.5 mm long. **Fig. 7.**

***Additional specimens examined*:** **Western Australia.** Caffarelli Island, *c.* 300 km N of Derby, Apr 2000, *Mitchell 6123* (BRI, DNA, PERTH); King Hall Island, Buccaneer Archipelago, Jun 1982, *Hopkins BA0542* (PERTH); 81 km N from Willie Creek turn off on Beagle Bay Road, Mar 1986, *Foulkes 412* (BRI, DNA, PERTH).

***Distribution and habitat*:** *Ipomoea tolmerana* subsp. *occidentalis* occurs in Dampierland, north-western Western Australia, north to the Buccaneer Archipelago (**Map 3**). It grows on pindan plains, in open savannah woodland on sandy loam soils.

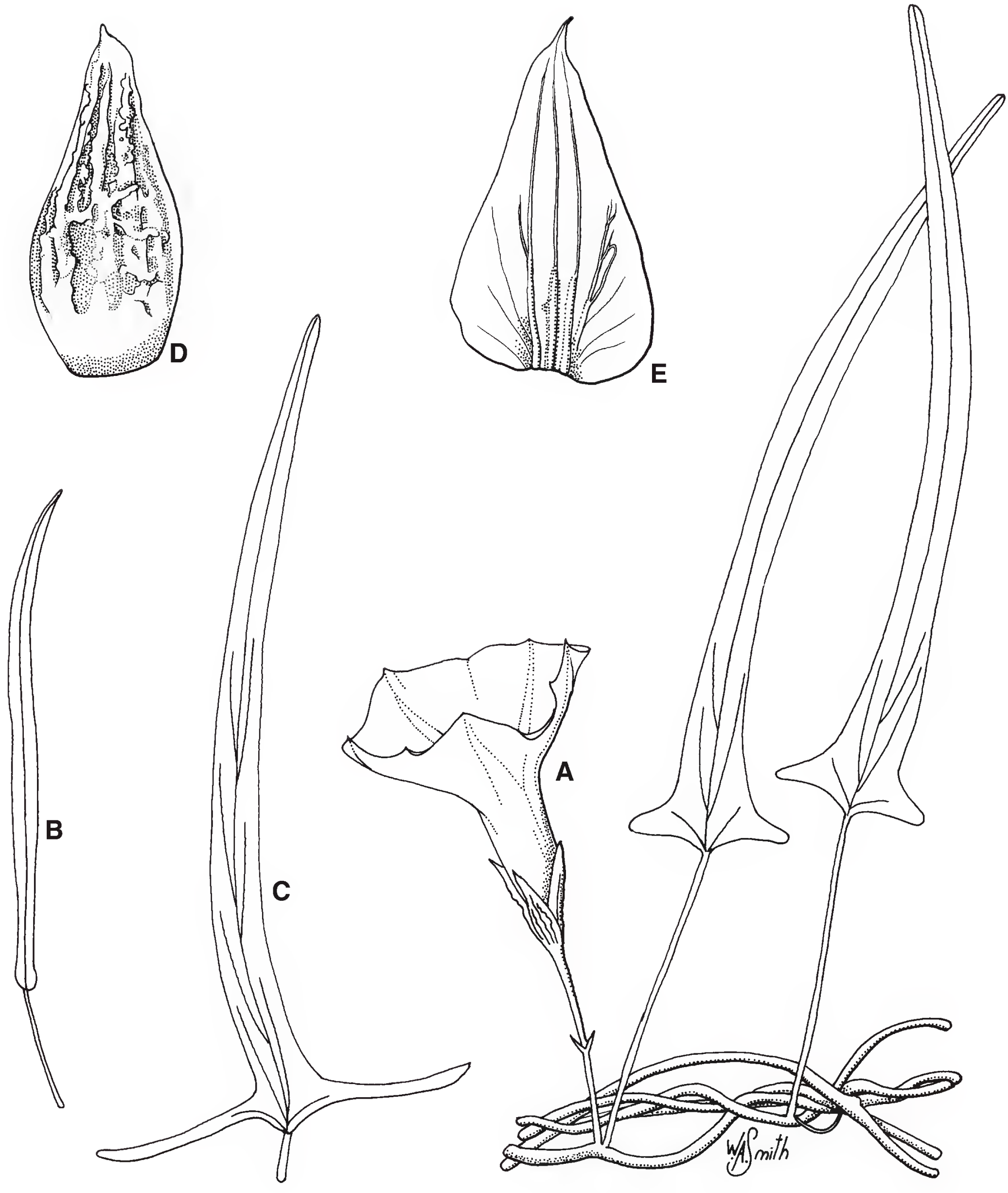

Fig. 7. ***Ipomoea tolmerana*** subsp. ***occidentalis***. A. flowering branch ×1. B–C. leaf variation ×1. D. outer sepal at flowering ×4. E. inner sepal at flowering ×4. A–E from *Mitchell 6669* (PERTH – holotype). Del. W.Smith.

***Phenology*:** Flowers and fruits have been recorded in March and April.

***Notes*:** *Ipomoea tolmerana* subsp. *occidentalis* differs from *I. tolmerana* subsp. *tolmerana* in the colour of the corolla. Populations of blue flowered species of *Ipomoea* occasionally sport white variants. However, in this case, flower colour in specimens of both the eastern and western subspecies appears constant. It also appears to have a smaller corolla and its outer sepals at flowering are shorter and inner sepals both shorter and wider than in the type subspecies.

***Conservation status*:** It is regarded as a priority 1 taxon in Western Australia (Western Australian Herbarium 2011).

***Etymology*:** The specific epithet is derived from the Latin *occidentalis,* meaning western. This refers to the western distribution of this subspecies.

Ipomoea versipellis R.W.Johnson **species nova**; affinis *I. antonschmidii* R.W.Johnson, sed laminis ± glabris usque ad dense piliferis (in ea semper dense piliferis), vix usque ad valde hastatis (non semper integris) et sepalis exterioribus sub anthesi longioribus, 10–16 mm longis (non 16–21 mm longis). Planta perennis, caules serpentes or volubiles. Folia simplicia, lamina ovata, hastata usque ad sagittata. Inflorescentia cymosa, 1–3-flora. Sepala exteriora laevia. Corolla infundibuliformis glabra. Semina pubescentes, caespite pilorum longiorum ad hilum. **Typus:** Northern Territory. Darwin & Gulf: Keep River National Park, Spirit Hills, *c.* 17 km NNW of Bullo River Homestead, 22 March 2009*, I.D.Cowie 12288* (holo: DNA [D191134]; iso: BRI, CANB *n.v*., MEL *n.v*., MO *n.v*., PERTH *n.v*.).

Ipomoea sp. B; Wheeler & Marchant (1992).

Ipomoea sp. OT Station (S.T.Blake 17676); Short *et al.* (2011).

Perennial with trailing and scrambling stems; **stems** terete, stout, herbaceous, becoming somewhat woody, very sparsely to densely hairy, hairs stout, tubercle-based, straight, curved to sinuate, ± erect, 0.3–1.2 mm long. **Leaves** simple, petiolate; **petiole** 10–50 mm long, 0.3–1 times as long as the blade, vestiture as for the stem**; blade** broadly ovate or ovate-oblong, barely to distinctly hastate to sagittate, 20–70 mm long, 10–50 mm wide, apex obtuse to rounded, rarely barely acute, mucronate, base subcordate to cordate with sinus up to 40% of the blade, ± glabrous to densely hairy above, sparsely (hairs mainly on major veins) to densely hairy below, midrib with glands at the base and 4–7 pairs of secondary veins. **Inflorescence** axillary, cymose, 1–5(–10)-flowered; **peduncle** terete, 10–60 mm long, vestiture as for the stem; **bracteoles** opposite, herbaceous, narrow-linear to linear-subulate, 4–10(–20) mm long, 0.5–1 mm wide, acute, vestiture as for leaves, persistent; **pedicels** terete, 3–15(–23) mm long, vestiture as for the stem**,** with distinct slit-like glands 0.5–1 mm long under the calyx. **Outer sepals** narrowly ovate, ovate to ovate-elliptic, apiculate, 9–16 mm long, 3.5–5.5 mm wide in flower, with a length:width ratio of 2.5–3.5, extending to 8 mm wide in fruit, apex acute, with 5 raised ribs, moderately to densely hairy; **inner sepals** ovate to broadly ovate, acuminate, 10–15 mm long, 5.5–6.5 mm wide in flower, broader in fruit, apex rolled, acute, base truncate, with a broad hyaline margin, especially at the base, with 3–5 veins, glabrous or with hairs on the veins. **Corolla** funnel-shaped, 30–40 mm long, 30–40 mm diameter, deep pink to purple; **petals** 40–65 mm long, midpetaline band glabrous. **Stamens** 5, included, attached to the base of the corolla for 7–9 mm; **filaments** free for 9–17 mm, with multicellular hairs from just below the point of attachment upwards for 6–9 mm; **anthers** oblong, sagittate, 3–4 mm long, *c.* 1 mm wide, with basal lobes 0.5–0.75 mm long; **pollen** globular, spinulose. **Ovary** 2-locular on a prominent disk, glabrous; **style** 20–24 mm long**; stigma** biglobular**. Capsule** globular, *c.* 11 mm long, with a persistent style base, valvate-dehiscent, glabrous; **seeds** 4, 4.5–5.5 mm long, dark brown to black, densely puberulent with a tuft of long whitish brown hairs to 2 mm around the hilum. **Fig. 8.**

***Additional specimens examined*: Western Australia.** Durack River, *c.* 80 km SSW of Wyndham, May 1976, *Beauglehole 51440* (BRI, PERTH); Canyon Creek, near meatworks on Packsaddle Plain, Kununurra, Mar 1993, *Mitchell 2824* (BRI, PERTH); Lake Kununurra

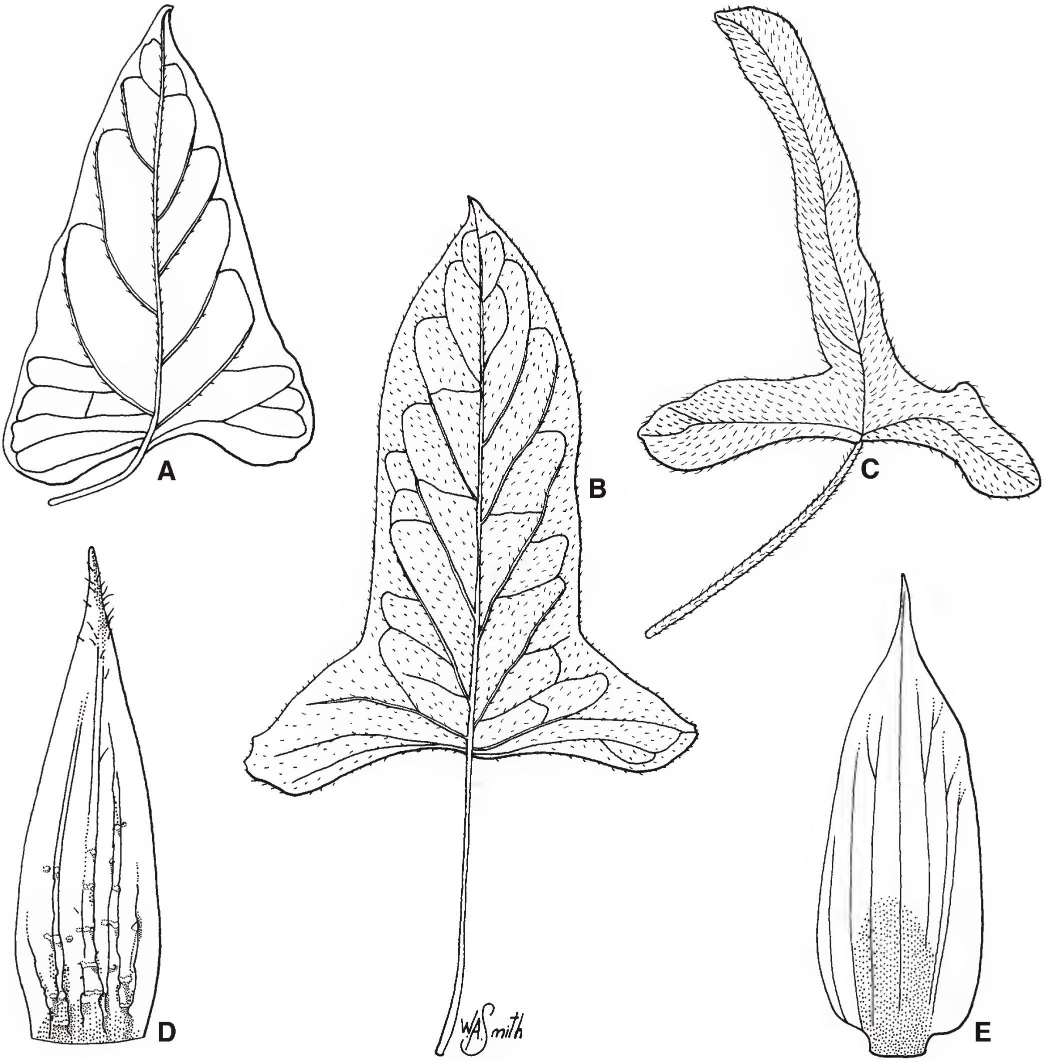

Fig. 8. ***Ipomoea versipellis***. A. cauline leaf ×1. B. cauline leaf ×0.5. C. cauline leaf ×1. D. outer sepal at flowering ×4. E. inner sepal at flowering ×4. A–B from *Cowie 12288* (DNA – holotype); C from *Brennan 4404* (DNA); D–E from *Mitchell 2824* (BRI). Del. W.Smith.

(Ord River), upper reaches of Noogoora Burr Creek, Nov 2001, *Handasyde TH01 301, 301b* (BRI, PERTH). **Northern Territory.** Upper Fitzmaurice River, Mar 1989, *Leach & Dunlop 2458* (BRI, DNA); Yamburran Range, Mar 1989, *Leach & Dunlop 2470* (BRI, DNA); Yamburran Range, Mar 1989, *Russell-Smith & Lucas 7682* (DNA); Bradshaw Station, near fire plot 3, Feb 1999, *Michell 2181* (DNA); Spirit Hills Conservation Reserve, Mar 2006, *Dixon 1598* (BRI, DNA); Spirit Hills, *c.* 18 km N of Bullo River Homestead, Apr 2007, *Kerrigan 1197* (DNA); Bullo River Station, towards western boundary, Bullo 29, Mar 2006, *Lewis 499* (DNA); 45 km SSW of Legune Station, Mar 1989, *Russell-Smith & Brock 7565* (BRI, DNA); Keep River N.P., Spirit Hills area, *c.* 35 km SW of Bullo River Homestead, Mar 2009, *Cowie 12309* (BRI, DNA); Gregory N.P., headwater of tributary of East Baines River, *c.* 46 km due SW of Timber Creek, Apr 1996, *Walsh 4357* (DNA, MEL); Gregory N.P., Jasper Creek, Apr 1996, *Woodward 12 & Booth* (DNA); Jasper Gorge area, 11 km SW of gorge, Apr 2000, *Brennan 4404* (DNA); Gregory N.P., Snake Creek, Apr 1996, *Booth & Jones 1673* (BRI, DNA); Gregory N.P., near top of falls, upstream on creek, *c.* 45 km SSW of Bullita Outstation, Apr 1996, *Duretto 1119*

& Davies (DNA); O.T. Station, May 1947, *Blake 17676* (BRI, DNA); Gregory N.P., Depot Creek, *c.* 27 km ENE of Limbunya, Apr 1996, *Cowie & Jones 6242* (BRI, DNA, PERTH).

Distribution and habitat**:** *Ipomoea versipellis* occurs in the Drysdale River area of the Kimberley, Western Australia, extending into the Northern Territory, as far north as Litchfield N.P., as far south as Gregory N.P. and eastward to the O.T. Station, SW of Borroloola (**Map 3**). It grows in a variety of vegetation communities from eucalypt woodlands to riverine forests and vine thickets on sandy soils on rocky slopes in dissected sandstone country.

Phenology**:** Flowers have been recorded from February to May and also in November; fruits have been recorded from February to May, also in August and November.

Affinities**:** *Ipomoea versipellis* is closely related to *I. antonschmidii* which occurs to the east in north-western Queensland. However, the latter species is always densely hairy and its leaves are never hastate. It also has longer sepals.

Conservation status**:** It is a widespread species and not known to be at risk.

Etymology**:** The specific epithet is from the Latin *versipellis,* meaning shape-changing, capable of altering its appearance. This refers to the variation that occurs in leaf shape from ± ovate-triangular to deeply hastate and indumentum from densely hairy to very sparsely hairy.

Key to species of native and naturalised* *Ipomoea* found in Australia; endemic Australian species indicated^{E}

1 Leaves pinnately cut into numerous linear segments; corolla scarlet, salver-shaped (NSW, NT, Qld, WA) . . . . *****I. quamoclit**
1. Leaves not as above, or if so, then corolla not scarlet and salver-shaped. **2**

2 Outer sepals with awn ≥2 mm long, at or below the apex; corolla salver-shaped **3**
2. Outer sepals without a long awn; corolla funnel-shaped or campanulate, rarely salver-shaped. **4**

3 Corolla small, scarlet, ≤5 cm long, limb <3 cm across (NSW, NT, Qld, WA) . . . . *****I. hederifolia**
3. Corolla large, white, >5 cm long, limb >6 cm across (NSW, Qld). . . . . *****I. alba**

4 Corolla small, <1.5 cm long, rarely longer; sepals fimbriate; peduncles <2 cm long or absent **5**
4. Corolla >1.5 cm long or if less, then sepals not fimbriate; peduncles usually > 2mm long. **9**

5 Herbs with erect or decumbent stems; corolla pink to purple, never white, mid-petaline bands glabrous (NSW, NT, Qld, SA, WA) . . . . **I. polymorpha**
5. Annual or herbaceous perennial vines with stems twining, climbing or trailing; corolla pink, purple or white, mid-petaline bands hairy **6**

6 Ovary and capsule hairy; corolla pink to purple (NT, Qld, WA). . . . . **I. eriocarpa**
6. Ovary and capsule glabrous; corolla white **7**

7 Leaf base attenuate, rounded to truncate, never cordate (NSW, NT, Qld, SA, WA) . . . . **I. lonchophylla**^{E}
7. Leaf base cordate **8**

8 Leaves glabrous or very sparsely hairy on upper surface, moderately pilose on lower surface (arid NT, Qld, SA, WA) . . . . **I. racemigera**^{E}

8. Leaves evenly pilose on both surfaces (NSW, NT, Qld, WA) . . . . **I. plebeia**

9 Ovary and capsule 3-locular **10**
9. Ovary and capsule 2 or 4-locular **15**

10 Leaves digitate with 3–5 lobes, lobes coarsely and irregularly toothed to pinnatifid . . . **11**
10. Leaves entire or 3–5 lobed, not digitate, lobes entire. **12**

11 Corolla <1.5 cm long; sepals 2.8–5 mm long in flower (NT, Qld, WA) . . . . . . **I. coptica**
11. Corolla >4 cm long; sepals 6–14 mm long in flower (NT, Qld) . . . . **I. diversifolia**

12 Sepals ≤15 mm long, apex acute (NSW, NT, Qld) . . . . ***I. purpurea**
12. Sepals mostly >15 mm long with apex long attenuate to acuminate **13**

13 Sepals with ±appressed hairs <1 mm long; corolla limb >5 cm diameter; flowers in cymose clusters on long peduncles (NSW, Qld, SA, Vic, WA) . . . . ***I. indica**
13. Sepals with ascending to spreading hairs >1 mm long; corolla limb <5 cm diameter; flowers usually solitary or in 3's. **14**

14 Sepals abruptly narrowed with the long subacute tips strongly spreading or curved, hairs spreading, 3–4 mm long (Qld) . . . . ***I. hederacea**
14. Sepals gradually narrowed with the long acute tips suberect, straight, scarcely spreading, hairs ascending to spreading < 3 mm long (NT, Qld, WA) . . . ***I. nil**

15 Leaves palmately divided to the base or almost so **16**
15. Leaves entire or bearing only basal lobes, or if palmately lobed, then lobes cut less than two thirds of distance to base of blade **17**

16 Leaves and stems patently hairy (coastal NT, WA). . . . . ***I. pes-tigridis**
16. Leaves and stems glabrous (NSW, Qld, SA, WA) . . . . ***I. cairica**

17 Leaves narrow-linear, occasionally distinctly hastate, with a length:width ratio of 6–45; corolla white or lilac to mauve **18**
17. Leaves not linear, with a length:width ratio <5, if narrow-linear and hastate then corolla pink to purple **19**

18 Leaves entire; outer sepals much shorter than inner, surface smooth; corolla salver-shaped (NT, Qld, WA) . . . . **I. gramineaᴱ**
18. Leaves barely to distinctly hastate; sepals equal in length, longitudinal veins rugose; corolla funnel-shaped (NT, WA). . . . . **I. tolmeranaᴱ**

19 Corolla salver-shaped, white, rarely pale pink, ≥8 cm long; sepals mainly >20 mm long in fruit **20**
19. Corolla funnel-shaped to campanulate, pink or purple, rarely white or yellow, mainly <8 cm long; sepals mainly <20 mm long in fruit **23**

20 Stamens inserted near mouth of corolla tube (Qld). . . . .**I. aculeata**
20. Stamens inserted near the base of the corolla tube **21**

21 Leaves, sepals and mid-petaline bands of corolla hairy (Qld) . . . . . . **I. saintronanensisᴱ**
21. Leaves, sepals and mid-petaline bands of corolla glabrous **22**

22 Leaves mostly 3–5 lobed; stamens exserted; outer sepals much shorter than inner sepals (WA) . . . .**I. trichosperma**
22. Leaves mostly entire; stamens included; outer sepals equal or slightly shorter than inner sepals (NT, Qld, WA) . . . .**I. violacea (syn. I. macrantha)**

23 Marsh or aquatic plants; stems thick, hollow, rooting at nodes; capsules

indehiscent or dehiscing irregularly **24**
23. Rarely in marshy situations; stems herbaceous or woody; capsules valvate-dehiscent . . **25**

24 Corolla creamy-white, 1.5–2.5 cm long (NSW, NT, Qld, SA, WA) . . . **I. diamantinensis**^{E}
24. Corolla pink or pale lilac, often with a purple centre, rarely white, 3–6 cm long (NT, Qld, WA) . . . . **I. aquatica**

25 Leaves strongly emarginate to bilobed; stems trailing, rooting at the nodes; plants fleshy; growing on coastal dunes **26**
25. Leaves not strongly emarginate to bilobed **27**

26 Corolla pink or purple; peduncles 3–16 cm long (NSW, NT, Qld, WA) . . . . **I. pes-caprae**
26. Corolla white or yellowish with a purple centre; peduncles <2 cm long (NT, Qld) . . . . **I. imperati**

27 Sepals distinctly fimbriate; ovary usually hairy **28**
27. Sepals glabrous, occasionally hairy, not distinctly fimbriate; ovary mainly glabrous . . . **29**

28 Corolla 3–4 cm long (Qld, WA, also cultivated) . . . . ***I. batatas**
28. Corolla 1.5–2 cm long (NT, Qld, WA) . . . . ***I. triloba**

29 Leaves palmatifid with 5–7 lobes (Qld). . . . . **I. mauritiana**
29. Leaves entire or bearing only basal lobes. **30**

30 Corolla yellow, if whitish then corolla ≤5 cm long with a dark purple centre **31**
30. Corolla pink or purple, rarely whitish, if whitish then corolla >5 cm long **34**

31 Leaves fleshy, leaves ovate to oblong, apex obtuse to emarginated; outer sepals >8 mm long (NT, Qld). . . . . **I. imperati**
31. Leaves herbaceous, ovate to broadly ovate, acuminate, acute; outer sepals 3–6 mm long **32**

32 Corolla ≤1.5 cm long, yellow; sepals with some stout hairs 0.5–1.5 mm long, rarely glabrous (Qld) . . . . **I. brownii**^{E}
32. Corolla ≥2 cm long, rarely less, yellow to whitish, with a dark purple centre; sepals glabrous or sparsely pubescent with hairs <0.5 mm long. **33**

33 Corolla 2–2.5 cm long, pale yellow to whitish (Qld) . . . . ***I. obscura**
33. Corolla 2.7–5.5 cm long, yellow (Qld) . . . . ***I. ochracea**

34 Leaves glabrous or sparsely hairy **35**
34. Leaves moderately to densely hairy **54**

35 Sepals ovate, length:width ratio >2, apex acute to narrowly obtuse **36**
35. Sepals broadly ovate to orbicular, length:width ratio <2, apex broadly obtuse to rounded **46**

36 Seeds puberulent usually with a tuft of hairs around the hilum **37**
36. Seeds with longer hairs on the margins, sometimes glabrous **44**

37 Peduncle equal or shorter than the pedicels, mainly ≤1.5 cm long, ... **38**
37. Peduncle longer than the pedicels, mainly >1.5 cm long **40**

38 Leaves strongly hastate with narrow-linear terminal lobe and recurved linear to linear-triangular basal lobes; stems fibrous, becoming woody (Qld). . . . . **I. funicularis**^{E}
38. Leaves broadly ovate-triangular to deltoid, ovate to broad-ovate or ovate-oblong, truncate, sagittate to deeply cordate, rarely hastate at base; stems herbaceous **39**

39 Outer sepals bearing 3–5 raised, tuberculate, longitudinal veins (NT, Qld, WA) . . . **I. gracilis**^{E}
39. Outer sepals with a ± smooth surface, if veins raised then ± smooth (WA). . . . **I. kalumburu**^{E}

40 Corolla sky blue with a paler throat; sepals <7 mm long; seeds lacking tuft of hairs around hilum (Qld) . . . ***I. tricolor**
40. Corolla pink to purple, occasionally white, usually with a darker centre; sepals >7 mm long; seeds with a tuft of long hairs around the hilum . . . **41**

41 Outer sepals with a ±smooth surface, if veins raised then ±smooth (WA). . . **I. kalumburu**^{E}
41. Outer sepals bearing 3–5 raised, tuberculate, longitudinal veins . . . **42**

42 Leaves broad-ovate to ±reniform, cordate at the base (NT, Qld, WA) . . . **I. argillicola**^{E}
42. Leaves narrow-ovate to oblong-lanceolate, hastate to sagittate at the base . . . **43**

43 Stems, petioles and sepals at flowering with scattered stout hairs (NT, WA) . **I. versipellis**^{E}
43. Stems, petioles and sepals at flowering glabrous or rarely with occasional weak, not stout hairs and never on sepals (NT, Qld, WA) . . . **I. limosa**^{E}

44 Seeds glabrous or with hairs on the margins (Qld) . . . **I. tiliacea**
44. Seeds villous . . . **45**

45 Corolla ≤4 cm long; sepals at flowering <11 mm long; leaves entire (NT, Qld, SA, WA) . . . **I. muelleri**^{E}
45. Corolla >4 cm long; sepals at flowering >11 mm long; leaves usually with two rounded hastate lobes (NT, Qld) . . . **I. brassii**^{E}

46 Plant herbaceous with trailing stems, often rooting at the nodes, sometimes twining at the tips . . . **47**
46. Shrub or liana . . . **49**

47 Peduncle <2 cm long; corolla 3–4.5 cm long; sepals 6–9 mm long; seeds glabrous (Qld) . . . **I. littoralis**
47. Peduncle >2 cm long; corolla 5–9 cm long; sepals 7.5–25 mm long; seeds glabrous to villous . . . **48**

48 Corolla pink to purple; bracts 2–7 mm long, persistent; seeds glabrous to sparsely pubescent (NT, Qld) . . . **I. polpha**^{E}
48. Corolla white with a red-purple centre; bracts >10 mm long, caducous; seeds villous with longer hairs on margins and around the hilum (SA) . . . ***I. pandurata**

49 Peduncles >3 cm long, at least 3 times as long as pedicel . . . **50**
49. Peduncles mainly <3 cm long, never 3 times as long as pedicel . . . **51**

50 Erect shrubs; corolla with pubescent mid-petaline band (NT, Qld, SA, WA) . . . ***I. carnea**
50. Liana; corolla glabrous (Qld) . . . **I. tiliacea**

51 Sepals equal to sub-equal, mainly <13 mm long at flowering (NT, Qld, WA) . . . **52**
51. Inner sepals longer than outer, 12–22 mm long at flowering . . . **53**

52 Fruiting calyx equalling and enclosing the capsule, 11–55 mm long, strongly wrinkled, capsule with prominent style base . . . **I. abrupta**^{E}
52. Fruiting calyx not enclosing the capsule and not or barely wrinkled, capsule without prominent style base. . . . **I. dunlopii**^{E}

53 Leaves broad-ovate, orbicular or reniform, base cordate (NT, Qld, WA) . . . . . **I. costata**^{E}
53. Leaves lanceolate, usually rounded-hastate or sagittate, occasionally deeply lobed at the base (Qld, WA) . . . . **I. calobra**^{E}

54 Corolla with tomentose mid-petalline bands **55**
54. Corolla glabrous **56**

55 Shrub, stems not twining; sepals 8–11 mm long; bracts 2–3 mm long (WA). . . . . **I. yardiensis**^{E}
55. Stems twining; sepals >15 mm long; bracts 10–15 mm long (NT, WA) . . . **I. bracteolata**^{E}

56 Sepals at flowering broadly ovate, oblong or orbicular, obtuse, outer surface smooth . . **57**
56. Sepals at flowering ovate, acuminate to lanceolate, acute, surface with 5 raised, longitudinal veins **58**

57 Sepals at flowering to 11 mm long, if longer then sepals sparsely hairy; leaves acute to narrowly obtuse (NT, Qld, WA) . . . . **I. abrupta**^{E}
57. Sepals at flowering 8–10 mm long, moderately to densely hairy; leaves obtuse to rounded (Qld). . . . . **I. densivestita**^{E}

58 Leaves not lobed at the base; sepals 18–21 mm long (NT, Qld) . . . . . . **I. antonschmidii**^{E}
58. Leaves usually hastate to sagittate at the base; sepals ≤16 mm long (NT, WA) . . . . **I. versipellis**^{E}

Acknowledgements

I appreciate the continuing support provided by Gordon Guymer, Director of BRI, which enables me to continue my taxonomic research. I thank Will Smith (BRI) for the illustrations, Hans Dillewaard and Jenny Calway for their technical assistance and David Halford for his contributions while preparing the account for the *Flora of Australia*.

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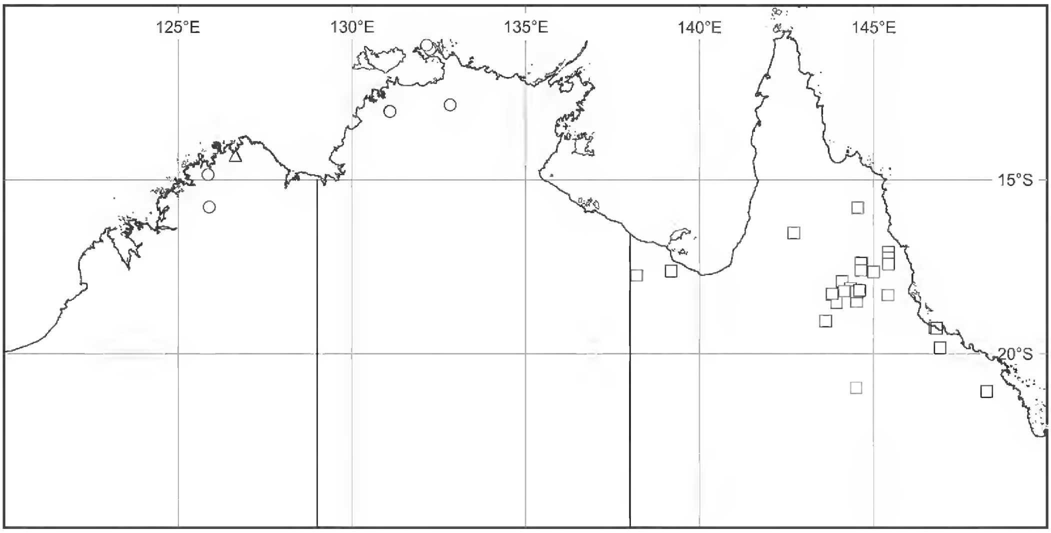
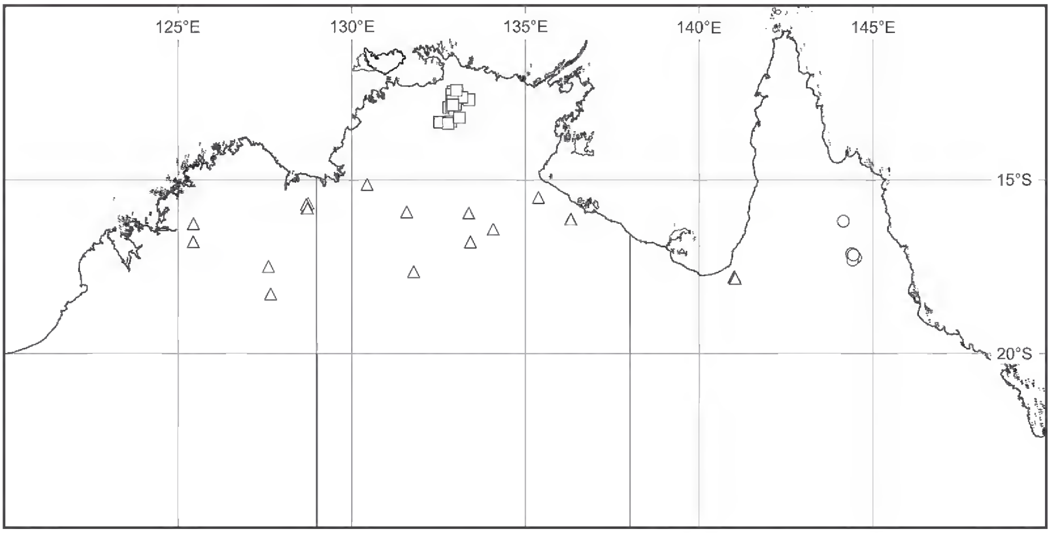
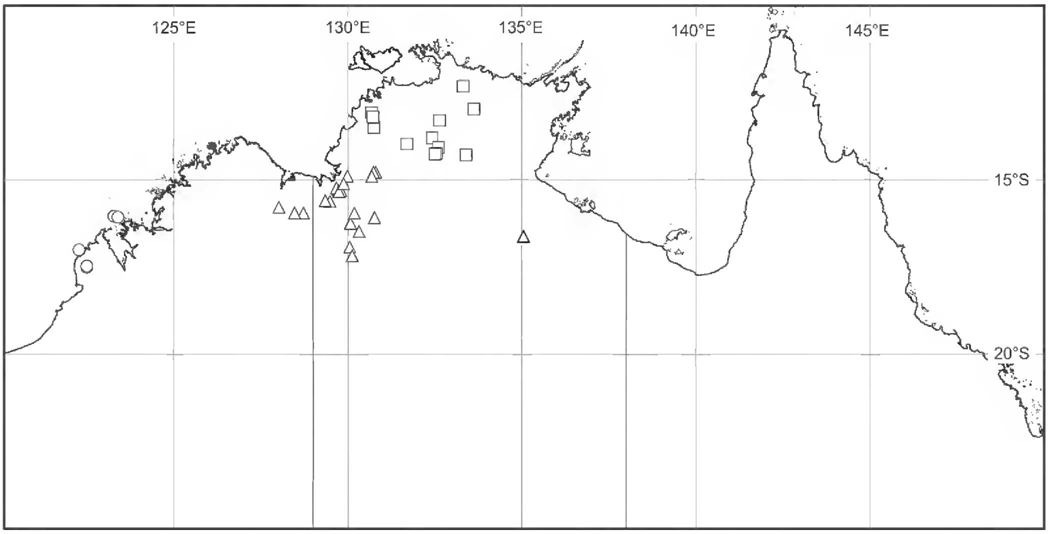

125°E
130°E
135°E
140°E
145°E
15°S
20°S

Map 1. Distribution of *Ipomoea bracteolata* ○, *I. funicularis* □, *I. kalumburu* Δ.


125°E
130°E
135°E
140°E
145°E
15°S
20°S

Map 2. Distribution of *Ipomoea densivestita* ○, *I. dunlopii* □, *I. limosa* Δ.


125°E
130°E
135°E
140°E
145°E
15°S
20°S

Map 3. Distribution of *Ipomoea tolmerana* subsp. *occidentalis* ○, *I. tolmerana* subsp. *tolmerana* □, *I. versipellis* Δ.

Referees consulted for Volume 8 of *Austrobaileya*

Acceptance of papers has depended on the outcome of review by referees. Those consulted for the current volume are listed below. Several were consulted on more than one occasion. Sincere thanks are extended to all these people whose expertise has helped to maintain journal standards.

D.Albrecht
D.F.Austin

R.Barrett
A.R.Bean
P.Berry
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